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ELECTRICAL SOUTH

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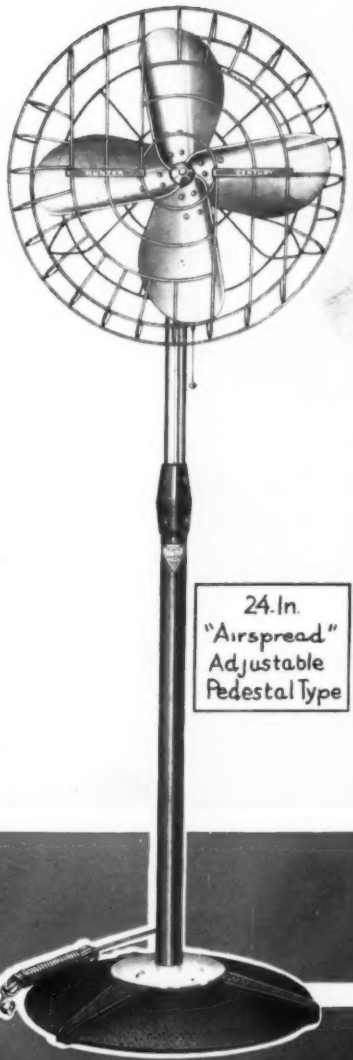

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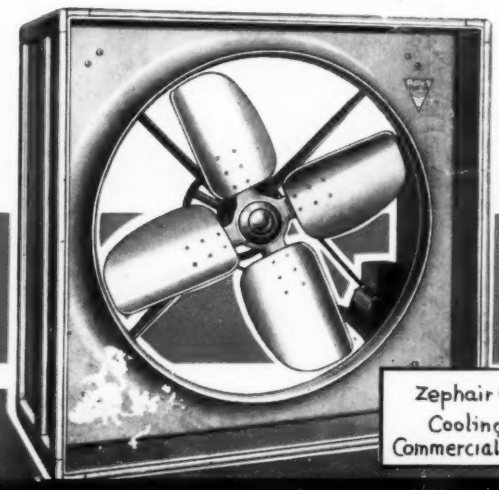

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25-36E

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Volume 22 Number 7

THE G-E LAMP DEPARTMENT IS

☆ ☆ ☆

What does this picture of Marty and his kid mean to all of us?

MARTY'S on the high seas now. But we know the things that'll help Marty most are more planes, more ships, more tanks, more shells.

A lot of these things that will help most are produced in small machine shops, as well as in large factories. General Electric is telling millions of people through advertisements in many publications that good light ... lots of light ... G-E fluorescent lighting can help increase production, cut rejects, reduce accidents—in short, help produce faster the things that Marty needs most.

Even so, we can't hope to tell everybody. It's encouraging to see the number of utilities that are organizing their lighting departments, their jobbers, their contractors into an all-out effort to give industry the best in lighting—to every plant, both large and small—to do this part now to help winning the war. Every one of General Electric's seventeen Lamp Division Offices will gladly help ... by supplying facts, folders, or other information. Or write General Electric Company, Dept. 166-FO-C, Nela Park, Cleveland, Ohio.

G-E MAZDA LAMPS
GENERAL ELECTRIC
Made to stay brighter longer

This is one of G.E.'s wartime lighting ads appearing in such publications as the Saturday Evening Post, Life, Time, Newsweek, *and many business and industrial magazines.*

This man, one of many G-E scientists, is studying the synthetic phosphors used in coating G-E MAZDA *Fluorescent lamps to make them stay brighter longer.*

LAMP PRODUCTION IN WAR—More than 400 types of G-E lamps are being produced for the Army, Navy, and Coast Guard . . . lamps for bombers and fighters, tanks and jeeps, mosquito boats and battleships. Millions of G-E MAZDA lamps . . . incandescent, fluorescent, and mercury . . . are lighting thousands of war production plants. General Electric is making lamps for safer seeing in homes, streets, and highways, for cars and other vehicles; special lamps for protection, blackout, and other vital needs.

ADVERTISING IN WAR—General Electric lamp advertising is telling millions of people through advertisements in many publications how light can help win the war by increasing production, reducing accidents, minimizing rejects.

SALESMEN IN WAR—As a quick, direct means for making lighting knowledge—accumulated over the years—available to many plants now under wartime pressure, the General Electric lamp department is offering its total manpower. Today, most of these men—including salesmen, engineers, and others with special qualifications—are actively at work in the field helping industry increase production with better lighting.

RESEARCH IN WAR—Typical of General Electric's lamp and lighting research is that done on the G-E MAZDA Fluorescent lamp which is proving such a vital war production tool. Up to June 1st, General Electric had put in hundreds of thousands of man hours of research to develop an improved fluorescent lamp that gives more and more light . . . that *stays brighter longer.* Research of this kind is behind every lamp that G.E. makes . . . is carried on month in and month out.

G-E MAZDA LAMPS

AT WAR

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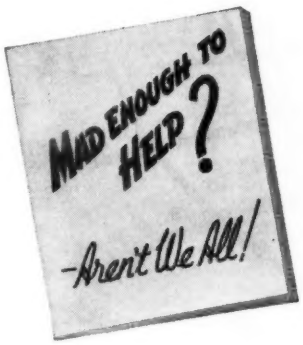
Are you Mad enough to help?

HERE'S A COMPLETE WAR LIGHTING SERVICE FOR UTILITIES!



Getting the right lighting in the right plants at the right time can help shorten and win the war. This places a big responsibility on the whole lighting industry. Who's going to do this job? How is it going to be done?

One thing we as the lighting industry *can* do, with our knowledge of the relation of proper lighting to increased production, is to step up our tempo of customer contact and service.

Another is to seek out all plants, large and small, faced with the problem of getting the most out of each shift, and make sure we are helping plant management remove bottlenecks that occur from improper lighting.

Another important job might be to organize in each community to see that every available man in the lighting industry both knows how to prescribe light for increased production and is out doing the job every day.

To help utilities do these jobs, the General Electric Lamp Department will gladly cooperate and offers suggestions and materials in the form of a complete service contained in the 14″ x 11″ folder illustrated at the left. Some of the supporting material is shown below.

Further information available through G-E Lamp Divisions. General Electric Company, Nela Park, Cleveland, Ohio.

SUGGESTIONS AND MATERIALS TO HELP WITH THE JOB!

1 WAR PRODUCTION LIGHTING HANDBOOK—a condensed 268-page pocket size book, containing lighting data and information.

2 SUGGESTED NEWSPAPER ADS available in mat form.

3 LIGHTING CALCULATOR—a handy slide rule for quickly determining the number of lamps and fixtures needed.

4 MEETING GUIDE AND SLIDE FILM—provides material for a talk to industry, built around a 50 frame slide film. Shows lighting bottlenecks and how to break them.

5 WARTIME LIGHTING RECOMMENDATIONS—a 4-page cover shows most types of general and local industrial and office lighting equipment. Holds forms for individual recommendations.

6 WAR PRODUCTION LIGHTING—36-page, 8½″ x 10″ book on production lighting for war industry. Shows advantages of good seeing, points out lighting bottlenecks, how to smash 'em.

GENERAL ELECTRIC

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Volume 22 No. 7

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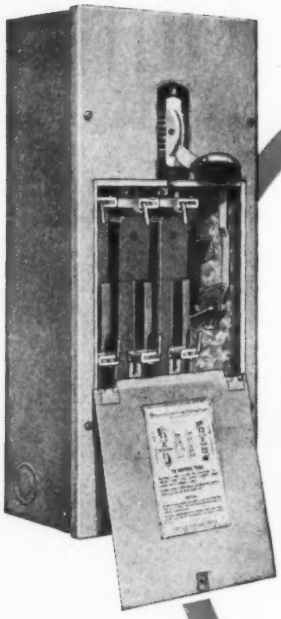
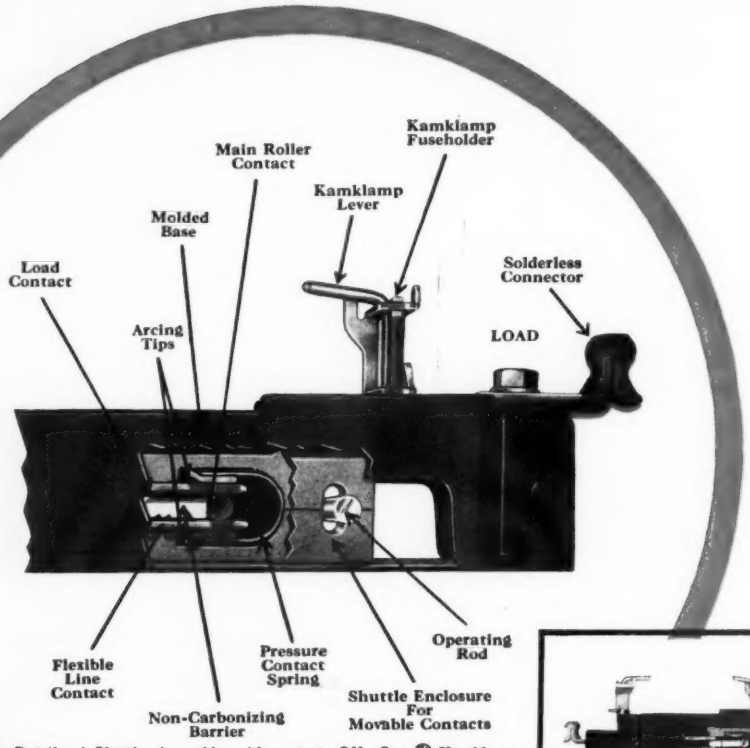
A Revolution in Safety Switch Design!



100 Amp., 575 Volt Ⓕ SHUTLBRAK Switch, Cat. No. SA-10633.



Details of Shuttle Assembly, with contacts ON. One Ⓕ Kamklamp fuseholder, and the new type Ⓕ Solderless Connector are shown. Note that the contacts are double break, and that they are held under compression by the pressure contact spring. This assures a perfect connection.

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Contacts in MAKE or BREAK position.

The contacts are shuttled ON and OFF—

that's why it's called the

Ⓕ SHUTLBRAK SWITCH

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As an additional safety factor, Type A is equipped with an interlocking arrangement between the switch operating lever and the door of the fuse compartment. The door cannot be opened when the handle is in the ON position. (Type B does not have this interlocking feature.)

Enclosures have ample wiring space at top, and AT REAR of the switching mechanism. Attractively finished in pearl gray enamel.

Front operated, the Ⓕ Shutlbrak Switch may be used singly, banked in groups, or assembled in compact, well designed switchboards and panelboards.

Capacities: 30 to 1200 amp., inclusive, for 250 volts AC or DC, and 30 to 600 amp., 575 volts AC, in 2, 3 and 4 poles. Approved by Underwriters' Laboratories.

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ELECTRICAL SOUTH

JULY, 1942

PLANNING FOR INDUSTRIAL

Lighting Maintenance

By W. H. Kahler*

This is the first of a series of three articles to be presented to assist architects, electrical contractors and industrial plant maintenance personnel in the servicing of lighting equipment.

●

LIGHTING practice in the last decade has advanced by leaps and bounds. The crying need of higher illumination levels and better quality lighting has been answered by the development of more efficient sources and new application techniques. This revolution in lighting has been accepted by industry for two reasons. First, industry realizes the real necessity of adequate illumination for efficient plant operation. Second, the cost of lighting per footcandle has been reduced to a point where higher lighting levels are economically practical.

There is one factor in lighting that has not advanced as rapidly in development or understanding. This factor is maintenance. Not a new word, not a new problem, but a factor that must be given considerably more attention by architects, lighting engineers and plant operators.

Maintenance of lighting is now more of a problem than ever before because the higher lighting levels require many more lamps and luminaires. Also, lighting is no longer just a means of making objects barely visible. It is a working tool that must be kept "sharp" and in good working order to obtain efficient, high speed production.

One of the important factors in designing a lighting installation is to provide for easy, inexpensive and safe access to luminaires for regular cleaning and relamping. Often this point is forgotten until the building is completed and then it is found that drastic steps must be taken to permit even the necessary relamping. Therefore, the building designer must assume the responsibility of thoroughly analyzing the maintenance problem and must provide for the proper accessibility of all luminaires.

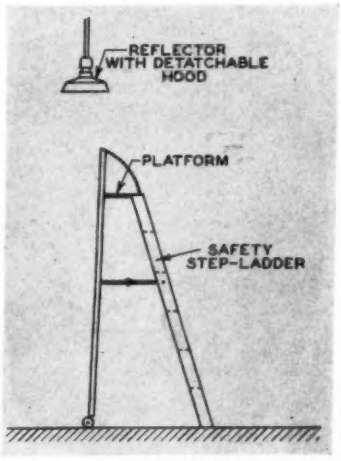


Fig. 1. Specially designed safety step ladder for use in servicing lighting units.

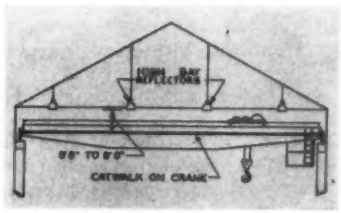


Fig. 2. Construction design that permits use of traveling crane for servicing high-bay units.

Also, the owners must plan their lighting maintenance schedule as part of plant operation. It is recommended that owner and architect collaborate on the maintenance problem as they would on other plant operation problems when related to building design.

No one method is suitable for every plant. Each factory is an individual case and should be studied as such. The following is a list of the most common means of access that are being used in plants throughout the country:

*Mr. Kahler is lighting engineer for the Westinghouse Lighting Division, Edgewater Park, Cleveland, Ohio.

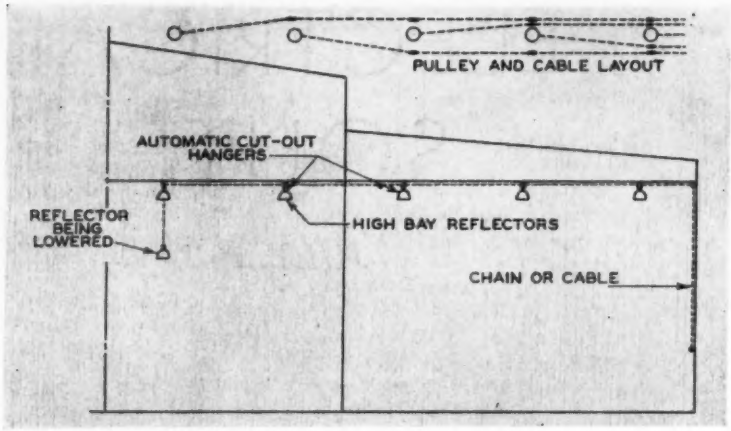


Fig. 3. Arrangement utilizing automatic cutout hangers in connection with pulley and cable system for lowering high-bay reflectors.

1. Ladder: step-ladder, "A" ladder or extension ladder.
2. Traveling crane.
3. Lowering devices for luminaires.
4. Portable telescoping platforms.
5. Monorail with traveling platform.
6. Catwalk.

Ladders: The common step ladder is the most universally used method for low mounted equipment. Step ladders up to 12 feet in length are not too awkward to handle and will permit access to reflectors as high as 15 feet or 16 feet above the floor. Figure 1 illustrates a ladder that is recommended because it is safe and easy to work on. Longer step ladders and the "A" type extension ladders can be used to reach equipment 18 feet to 20 feet above the floor, but are rather difficult to handle and may require considerable free floor space. For mounting heights of 18-30 feet, straight extension ladders are used, where luminaires are adjacent to an adequate support for the ladder.

Sometimes it is practical to arrange the luminaires close to the beams to provide easy access from an extension ladder. This method is not, however, generally recommended because it presents an accident hazard and may interfere with production of the floor.

Cranes: Lighting equipment mounted in high bays above a traveling crane may be easily accessible from the crane if two precautions are observed.

First, luminaires must be within easy reach of a man standing on the crane catwalk or the top of the crane beam (see Figure 2). It is a dangerous and expensive practice if a ladder must be set on the crane to reach lighting units. On very large cranes, it may be necessary to build a special platform on top of the crane carriage. This is relatively inexpensive and will reduce maintenance time as well as provide a safe means of access for the workmen.

Second, *all luminaires* must be within the crane travel. If a few units are located beyond the crane travel or beyond reach from a safe footing for the workman, it may be next to impossible to reach these units. By careful planning, these details can be easily worked out.

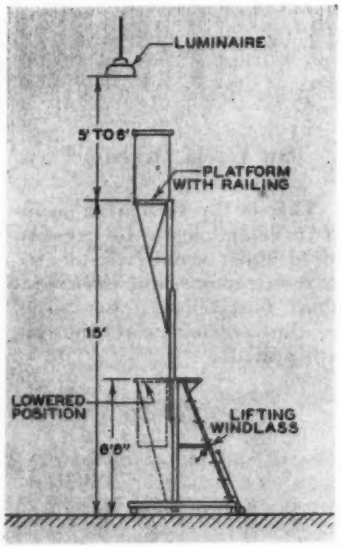


Fig. 4. Telescoping lift for maintaining high-bay lighting luminaires.

Lowering Hangers: Where lighting units cannot be easily reached by a ladder or no crane is available, a means of lowering the luminaires to the floor has proven to be the best solution in many high bay installations. The automatic disconnect type of lowering hanger is usually used because the lighting unit can be dropped to floor with power completely disconnected. These hangers are designed to carry the weight of filament lamp luminaires or the heavier fluorescent units. The hanger is operated by a cable or chain extending from the hanger to a convenient location along the wall or on catwalks in the trusses. Large installations are usually handled in the latter manner to avoid confusion of cables and to minimize cable lengths. Fluorescent units or other heavy types of luminaires are usually lowered by a small portable windlass rather than by hand. Although the equip-

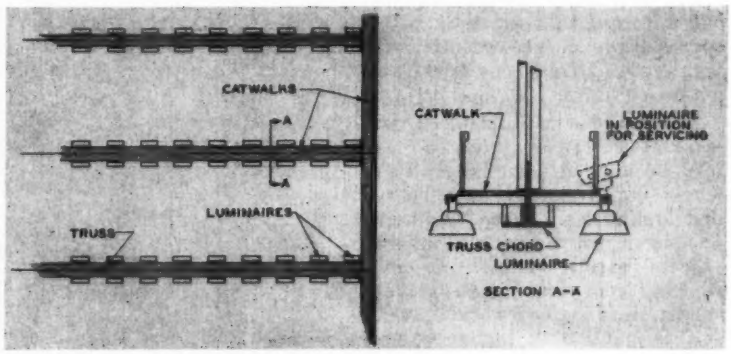


Fig. 5. Where the layout permits, catwalks will prove advantageous for reflector servicing. A general plan view of a typical catwalk system is shown at the left. At right, a detail view of catwalk showing reflector swung up into position for servicing.

ment is lowered or raised by chain or cable, the actual support in the operation position is a mechanical latch that relieves the chain or cable from continued strain. Figure 3 illustrates a typical installation of disconnect hangers.

Telescoping portable platforms are available in a variety of sizes for mounting heights of a wide range. This method of access to lighting is particularly suitable where the floor area is relatively clear of stationary machines or where there is no large apparatus in working progress. A small, compact and inexpensive telescoping platform is manufactured for access heights of 12 to 21 feet and is only 32 inches by 55 inches at the base (see Figure 4). For higher mounting heights, it is, of course, necessary to have a larger base on the platform, but special units are in use for mounting heights in the order of 40 or 50 feet.

Catwalks: Many of the new aircraft plants are faced with a tremendous maintenance problem because so many lamps and luminaires are in operation and often at mounting heights well above 20 feet. Ladders are difficult to handle, dangerous and many times out of the question due to lack of clear floor space. Portable platforms require too much space in the factory buildings in which the floor is literally covered with equipment. Even lowering hangers are not always practical because the luminaires may be directly above large machines or large planes which might interfere with dropping the unit to floor level. Many of these plants do not have traveling cranes.

Therefore, the only practical alternative is to provide some access to luminaires from above. At least two methods are possible and are being used. One is to install a system of catwalks parallel to the rows of reflectors and the other is to provide a monorail system which carries a traveling platform.

A typical catwalk system is illustrated in Figure 5. Luminaires are installed in rows along both sides of the trusses and a catwalk is mounted on the luminaire supports. The luminaires are pivoted on their supports so that they can be inverted to be readily accessible from the catwalk. This scheme was developed for the southern Bell Bomber Plant by the electrical engineers on the job.

The catwalks provide access to *all* luminaires without any interference with the flow of production on the floor. This is a real advantage when the plant operates 24 hours a day 7 days a week at peak production rate.

Fig. 7. Handling of fixtures is reduced to a minimum by utilizing equipment that permits reflector and lamp to be removed as a unit. Clean units are installed; units removed are then cleaned and used to replace other dirty units.

Fig. 8. Regular cleaning of luminaire lens assures maximum footcandle visibility.

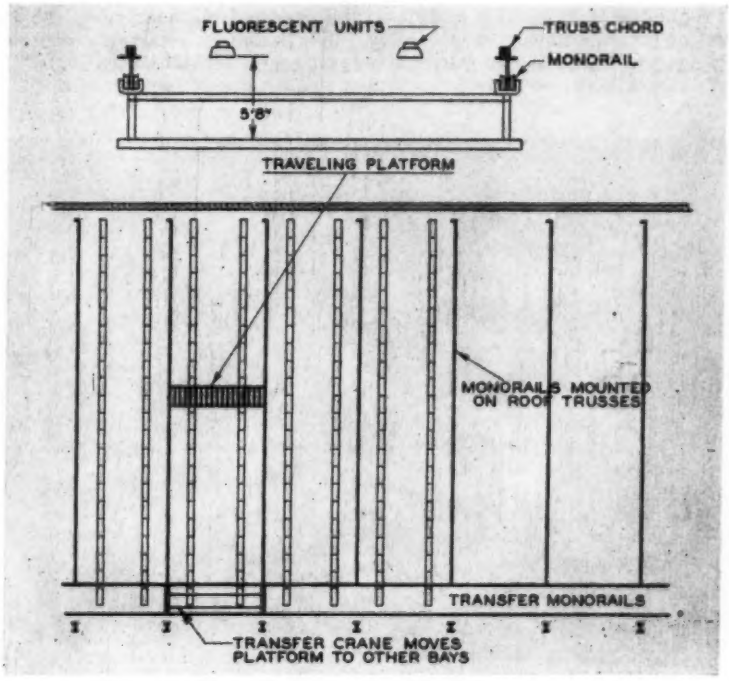


Fig. 6. Details of traveling platform suspended from monorails. A transfer crane moves platform from bay to bay.

Monorails: A complete system of light weight monorails designed to carry a traveling platform or bridge is another means of access that permits uninterrupted maintenance with safety and no interference with production. One such plan is shown in Figure 6. The traveling platform can be moved from one bay to another by a light weight transfer crane that travels on monorails installed

(Continued on page 62)

How to Keep 'em Turning

Motor maintenance programs must be intensified in these days of 24-hour production schedules. A comprehensive discussion of motor inspection routine and service is presented here.

By O. F. Vea*

PRESENT-DAY conditions make it necessary that all electric motors be babied. Maintenance programs must be intensified to prevent breakdowns, because 24-hour-a-day, 7-day-a-week war production schedules cannot be interrupted — output lost today cannot be made up tomorrow. Even the failure of an inconspicuous piece of equipment can cause a considerable disruption in production.

On the other hand, industrials engaged in nonwar activities must "keep 'em turning" as long as possible because of the difficulty in obtaining new motors without the necessary priority rating.

This article will discuss a general maintenance program. Wherever available, the specific instruction sheet accompanying each motor should be followed.

Connecting the Motor

All electrical connections to a motor should be made tightly enough so that the vibration of the equipment will not loosen them. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape, and then with friction tape.

Wires issuing from a conduit box, especially rubber-covered extension cords, should be held in some way so that there is no strain on the connections themselves. Usually a knot in the wire inside the conduit box, or the use of conduit-box fittings that grip the wire where it leaves the box, are the most convenient ways to obtain this strain relief.

A little extra care when starting a motor for the first time is a good investment. For example, trouble may be avoided by a look at the brushes of a direct-current or single-phase repulsion motor to make sure that they are seating properly on the commutator, and with the proper pressure. It is always good practice to turn the motor over by hand before applying power to be sure that it turns freely, and that no foreign materials or objects have fallen into the motor during shipment or handling.

Practical Inspection Program

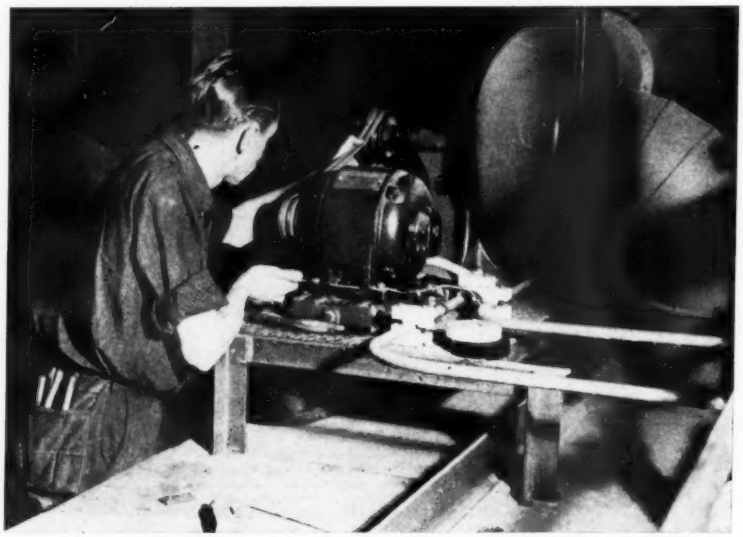
When the motor has been properly selected, installed, and connected, the maintenance program really begins. To insure efficient opration and maximum production, inspection and servicing should be systematic.

Frequency of inspection and degree of thoroughness vary, and will have to be determined by the maintenance engineer. They will be governed by (1) the importance of the motors in the production scheme (that is, if the motor fails, will the whole works be shut down?), (2) percentage of time the motor operates, (3) nature of service, (4) environment.

An inspection schedule must, therefore, be elastic and adapted to the needs of each plant. The following schedule, covering both a-c and d-c motors, is based on average conditions in so far as duty and dirt are concerned:

Every Week

1. Examine commutator and brushes
2. Check oil level in bearings
3. See that oil rings turn with shaft
4. See that shaft is free of oil and grease from bearings
5. Examine starter, switch, fuses, and other controls



Install the motor in such a way that it is accessible for inspection and repairs. Care should be taken to align the motor properly with the driven load.

*Mr. Vea is in the motor division of the General Electric Company, Schenectady, N. Y.

6. Start motor and see that it is brought up to speed in normal time.

Every Six Months

1. Clean motor thoroughly, blowing out dirt from windings and wipe commutator and brushes
2. Inspect commutator clamping ring
3. Check brushes and renew any that are more than half worn
4. Examine brush holders and clean them if dirty. Make sure that brushes ride free in holders
5. Check brush pressure
6. Check brush position
7. Drain, wash out, and renew oil in sleeve bearings
8. Check grease in ball or roller bearings
9. Check operating speed or speeds
10. See that end play of shaft is normal
11. Inspect and tighten connections on motor and control
12. Check current input and compare with normal
13. Run motor and examine drive critically for smooth running, absence of vibration, worn gears, chains, or belts
14. Check motor foot bolts, endshield bolts, pulley, coupling, gear and journal setscrews, and keys
15. See that all motor covers, belt and gear guards are in good order, in place, and securely fastened.

Once a Year

1. Clean out and renew grease in ball or roller bearing housings
2. Test insulation by megger
3. Check air gap
4. Clean out magnetic dirt that may be hanging on poles
5. Check clearance between shaft and journal boxes of sleeve-bearing motors, to prevent operation with worn bearings
6. Clean out undercut slots in commutator
7. Examine connections of commutator and armature coils
8. Inspect armature bands.

The competent maintenance man will have a record card for every motor in the plant. All repair work, with its cost, and every inspection can be entered on the record. In this way, excessive amounts of attention or expense will show up and the causes can be determined and corrected.

Inspection records will also serve as a guide to tell when motors should be replaced because of the high cost to keep them in operating condition. Misapplications, poor drive engineering, and the like will also be disclosed.

Check oil level in sleeve bearings frequently. This is especially important today because of the scarcity of bearing material.

Proper Lubrication

One of the major features of a maintenance program, from the standpoint of effect upon the general performance of a motor, is proper lubrication.

The point has now been reached where the bearings of modern motors, whether sleeve, ball or roller, require only very infrequent attention. However, oiling and greasing of new motors is quite often entrusted to careless attendants who have been used to lubricating older designs, with housings less tight than on modern machines.

As a result, oil or grease is copiously and frequently applied to the outside as well as the inside of bearing housings. Some of the excess lubricant is carried into the machine and lodges on the windings, where it catches dirt and thereby hastens ultimate failure.

If the proper amount of a suitable lubricant is applied before starting, there should be no need to refill the housings for several months, even in dusty places.

Only a high grade of grease, having the following general characteristics, should be used for ball-bearing lubrication:

1. Consistency a little stiffer than that of vaseline, maintained over the operating-temperature range.
2. Melting point preferably over 150° C.
3. Freedom from separation of oil and soap under operating and storage conditions.
4. Freedom from abrasive matter, acid, and alkali.

In greasing a motor, care must be taken not to add too large a quantity of grease or it will cause too high an operating temperature with resulting expansion and leaking of the grease, especially with large bearings operated at slow speeds.

The following procedure is recommended for greasing ball-bearing motors equipped with a pressure-relief greasing system:

Make sure that no dirt gets into the bearing with the grease by wiping clean the pressure-gun fitting, bearing housing, and relief plug. Always remove the relief plug from the bottom of the bearing before using the grease gun. This prevents putting excessive pressure inside the bearing housing. Excessive pressure might rupture the bearing seals.

With a clean screw driver or similar tool, free the relief hole of any hardened grease, so that any excess grease will run freely from the bearing. With the motor running, add grease with a hand-operated pressure gun, until it begins to flow from the relief hold. This tends to purge the housing of old grease. If it might prove dangerous to lubricate the motor while it is running, follow the procedure with the motor at a standstill.

Allow the motor to run long enough after adding grease to permit the rotating parts of the bearing to expell all excess grease from the housing. This very important step prevents over-greasing the bearing. Finally, stop the motor and replace the relief plug tightly with a wrench.

A motor that is not equipped with the pressure-gun fitting and relief plug on the bearing housing cannot be greased by the procedures previously described.

Grease at One-Year Intervals

Under average operating conditions, the grease with which the bearing housings of these motors were packed before leaving the factory is suffcient to last approximately one year. When the first year of service has elapsed, and once a year thereafter (or oftener if conditions warrant) the old grease should be removed and the bearings supplied with new grease.

To do this, disassemble the bearing housings and clean the inside of the housings and housing plates — or caps — and the bearings, with carbon tetrachloride. When thoroughly cleansed of old grease, reassemble all parts except the outer caps, or plates.

Apply new grease, either by hand or from a tube, over and between the balls. The amount of grease to be used varies with the type and frame size of the particular motor. The instruction sheet which accompanied the motor should be consulted for this information.

Addition of the correct amount of grease fills the bearing housings one-third to one-half full. More than the amount specified must not be used. When reassembling the motor, any V-grooves that are found in the housing lip should be refilled with grease—preferably a fibrous, high-temperature-sealing grease—which will act as an additional protective seal against the entrance of dirt or foreign particles.

The technique for greasing motors equipped with roller bearings is very similar to that used for ball bearings.

Specific instructions for the individual design should be followed, however, because more frequent greasing or slight changes in technique may sometimes be necessary.

Oiling Sleeve Bearings

The oil level in sleeve-bearing housings should be checked periodically with the motor stopped. If the motor is equipped with an oil-filler gage, the gage should be approximately three-quarters full at all times.

If the oil is dirty, drain it off by removing the drain plug, which is usually located in the bottom or side of the bearing housing. Then flush the bearing with clean oil until the outcoming oil is clean.

In fractional-horsepower motors, there may be no means of checking oil level, as all the oil may be held in the waste packing. In such cases, a good general rule for normal motor service is to add thirty to seventy drops of oil at the end of the first year and to re-oil at the end of each subsequent one-thousand hours of motor operation.

Most fractional-horsepower motors built today require lubrication about once a year. Small fan and agitator motors will often require more frequent lubrication, with three-month intervals between oilings.

Sleeve bearing housings are provided with liberal settling chambers into which dust, dirt, and oil sludge collect. The only cleaning necessary is to remove the drain plug and drain the oil, which will flush out most of the settled material with it.

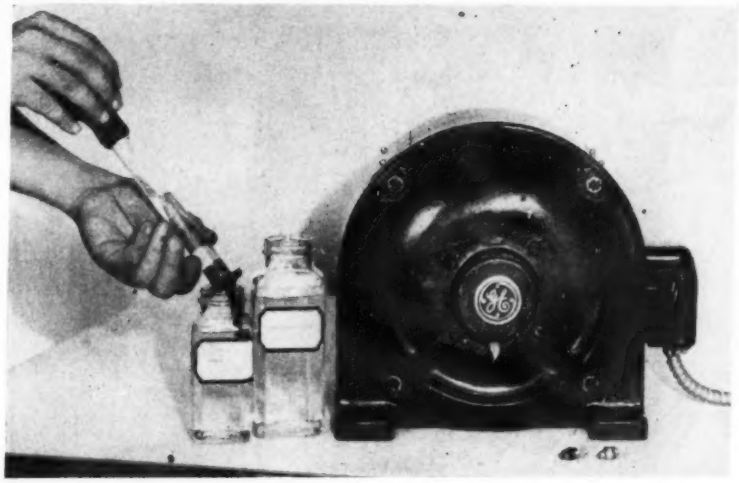
Whenever the motor is disassembled for general cleaning, the bearing housing should be washed out with a solvent. Before being assembled, the bearing lining should be dried and the shaft covered with a film of oil.

Cleaning Ball Bearings

The pressure-relief method of greasing motors, described above, tends to purge the bearing housing of used grease. Complete cleaning of bearings, therefore, is required at infrequent intervals only. For a thorough and convenient flushing when the bearings are not disassembled, the following method is recommended:

Wipe clean the housing, pressure-gun, and relief fittings, and then remove both fittings. Every care should be taken to keep dirt out of the bearings. A bit of abrasive once in a bearing may not be removed even with the most thorough cleaning. Afterwards, it may become dislodged and get between the bearing surfaces with serious results.

For convenience of maintenance man, many motors have ball bearings arranged to be greased with a pressure gun. Here is a standard ball-bearing open motor being greased after hardened grease has been rmoved. Pressure-relief greasing system facilitates adding correct amount of grease.



Thorough cleaning of ball-bearing housings at periodic intervals is beneficial in obtaining long bearing life. Housing of this motor can be flushed without disassembling the motor.

With a clean screw driver or a similar tool, free the pressure-fitting hole in the top of the bearing housing of hardened grease. Also, free the relief-plug hole in the bottom of the housing from old grease to permit easy expulsion of the old grease during the cleaning process after the solvent is added.

Fill a syringe with grease solvent, such as carbon tetrachloride, and inject some of it into the bearing housing through the pressure-fitting hole, while the motor is running. As the grease becomes thinned by the solvent, it will drain out through the relief hole. Continue to add solvent until it drains out quite clear.

Replace the relief plug and inject solvent until it can be seen splashing in the filling hole. Allow the solvent to churn for a few minutes, and then remove the relief plug and drain off the solvent. Repeat the churning operation until the solvent runs clean.

When using carbon tetrachloride for flushing, replace the relief plug and inject a small amount of light lubricating oil. Allow it to churn for a minute or two before draining off. This will flush out the solvent. To complete the job, grease the bearing, using the method previously described.

This method permits the cleaning of all standard motors operating at an angle not exceeding 15 degrees from the horizontal (except totally enclosed, fan-cooled motors). For these motors, the bearing at the pulley end may be flushed as described. To clean the fan-end bearing, first remove the fan cover and fan in order to make accessible the drain plug at the bottom of the housing.

Care of Insulation

Care of insulation goes hand in hand with lubrication as one of the major features of a motor maintenance program. These features concern the most vital, and probably the most vulnerable, parts of a motor.

Motors should always be stored in a dry, clean place until ready for installation. Heat should be supplied to protect against alternate freezing and thawing.

Motors that have been long in transit in a moist atmosphere, or idle for an extended period, should be thoroughly dried out before being placed in service. Since machines sometimes "sweat" as a result of a difference in their temperature and that of the surrounding air, they should be kept warm at all times to prevent this condition.

Current at a low voltage can be passed through the windings, electric heaters can be used, or even steam pipes can be utilized for protective purposes. In the case of extended idle periods, tarpaulins may be stretched over the motor and a small heater put inside to maintain the proper temperature.

The most effective method of drying out motors that have become wet by accident or because of "sweating" is to pass current through the windings, using a voltage low enough to be safe for the winding in its moist condition.

Thermometers should be placed on the windings to see that they are heated uniformly. Temperatures should not exceed 90° C. (Class A insulation). This method is particularly effective on high-voltage motors, where the insulation is comparatively thick.

Heat can be supplied externally by placing heating units around the machine, covering with canvas, and leaving a vent at the top to permit moisture to escape. In doing this, it is essential that there be a circulation of warm air over all the surfaces to be dried.

Twelve-inch fans set to blow air across the fronts of "glow heaters" and then into the lower part of a motor from opposite sides will produce excellent results. The temperature of the winding should not be allowed to exceed 100° C. for Class A insulated motors. Smaller machines can be placed in ovens, the same temperature limits being observed.

Insulation Resistance Tests

The time required for complete drying-out depends considerably on the size and voltage of the motor. Insulation resistance measurements should be taken at intervals of four or five hours until a fairly constant value is reached. These tests are a good indication of the general condition of the insulation and its ability to stand the operating voltage.

The resistance should, at least, equal the AIEE standard which is:

$$\text{Megohms} = \frac{\text{Rated voltage of mach.}}{\frac{\text{Rating in kva}}{100} + 1000}$$

Insulation resistance tests should also be made before a high-potential test, to determine whether the insulation is ready for such a test, and afterwards to make certain that the high-potential has not injured the insulation.

High potential tests should be made after drying out or after repairs to check the dielectric strength of the insulation.

New windings should successfully stand a high-potential test of twice normal voltage plus 1000. Motors that have been in operation for some time should be tested with this method, *after thorough cleaning and drying*, using a voltage of about 150 per cent of normal

voltage, applied for one minute.

Small high-potential testing sets are available for such work and are of such capacity that very little damage will result from a breakdown during the test.

Cleaning Motors

A systematic and periodic cleaning of motors is necessary to insure best operation. While some machines are installed where dust, dirt, and moisture are not present, most motors are located where some sort of dirt accumulates in the windings.

Steel-mill dusts are usually highly conductive, if not abrasive, and lessen creepage distances. Other dusts are highly abrasive and actually cut the insulation in being carried through by the ventilating air. Fine cast-iron dust quickly penetrates most insulating materials.

Hence the desirability of cleaning the motors periodically. If conditions are severe, open motors might require a certain amount of cleaning each day. For less severe conditions, weekly inspection and partial cleaning are desirable.

For the weekly cleaning, the motor should be blown out with dry, compressed air (about 25 to 30 lb. per sq. in. pressure). Where conducting and abrasive dusts are present, even lower pressure may be necessary, and suction is to be preferred, as damage can easily be caused by blowing the dust and metal chips into the insulation. On larger d-c machines, the air ducts should be blown out so that the ventilating air can pass through as intended.

In cleaning a motor, the heavy dirt and grease should first be removed with a heavy, stiff brush, wooden or fiber scrapers, and cloths. Rifle-cleaning brushes can be used in the air ducts. Dry dust and dirt may be blown off, using dry compressed air at moderate pressure. Care must be taken to direct the air so that dust will not be pocketed in the various corners.

Grease, oil, and sticky dirt are easily removed by applying cleaning liquids like carbon tetrachloride, gasoline, or naphtha. There are several good methods of applying the cleansing liquid. Probably the best method is to spray it on. Care must be taken not to soak the insulation by dipping coils or small motors into the liquid.

While the insulation will dry quickly at ordinary room temperature after cleaning, it is highly desirable to heat it to drive off all moisture before applying varnish. If the motor can be spared from service long enough, the insulation should be dried out by heating to from 90° to 100° C.

Connections to a motor should be made tightly enough so that the vibration of the equipment will not loosen them. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape, and then with friction tape.

While the motor is warm, a high-grade insulating varnish should be applied. For severe acid, alkali, or moisture conditions where oil or dusts are present, special varnishes can be supplied.

The varnish may be sprayed or brushed on. For small stators or rotors, it is best to dip the windings into the varnish, cleaning off the adjacent metal parts afterwards by using a solvent of the varnish. After applying the varnish, the best results are obtained by baking for a length of time recommended by the varnish manufacturer, which often is from 3 to 7 hours at about 100° C.

If the machine must be put back in service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the quick-drying black or clear varnishes which dry in a few hours at ordinary room temperatures.

General Overhauling

Motors should generally be given an overhauling at intervals of five years or so, normally, or, if the service is more severe, more frequently. Such a practice is beneficial in avoiding breakdowns and in extending the useful life of the equipment. Where periodic overhauling is practiced, the following notes may be helpful.

Check the motor air gap, between stator and rotor, with feelers for uniformity. Small clearance at the bottom may indicate worn bearings.

Take the motor apart and inspect it thoroughly. Measurement of the bearings and journals may indicate need for new bearing linings. Remove the waste from waste-packed bearings and re-arrange or replace it, so that any glaze on the wool is removed from its point of contact with the shaft. Any gummy deposit means that the wool should be replaced. All lubricant should be cleaned out of the bearings and a fresh supply put in when the motor is reassembled.

The rotors should be cleaned with a solvent to remove any accumulated dirt, after which any rust should be removed with fine sandpaper (not emery paper). When clean and dry, the rotors should be coated with a good grade of clear varnish or lacquer to protect them from moisture. To prevent injury to the bearings, they should be completely protected with a clean rag when the motor is disassembled.

The rotors of wound-rotor motors should be given the same treatment as the stators. In addition, soldered joints and binding cords should be inspected and any

weakness should be remedied.

The stator bore should be cleaned of dirt with a solvent, and any rust should be removed with fine sandpaper (not emery paper). Care should be taken during this operation not to damage the top sticks or end turns of the stator winding. Then the stator bore has dried, any remaining dirt in the bore should be wiped out with a cloth or brushed out with a soft brush. A hand bellows or dry compressed air at low pressure may also be used.

To insure efficient operation of d-c motors, the following inspection and servicing should be done systematically.

Keep motors free from dust and dirt by frequent wiping. This motor is arranged so that the nameplate can be quickly and easily read.

The first essential for satisfactory operation of brushes is free movement of the brushes in their holders. Uniform brush pressure is necessary to assure equal current distribution. Adjustment of brush holders should be set so that the face of the holder is approximately ⅛ inch up from the commutator; any distance greater than this will cause brushes to wedge, resulting in chattering and excessive sparking.

Check the brushes to make sure that they will not wear down too far before the next inspection. Keep an extra set of brushes available, so that replacement can be made when neeeded. Sand in new brushes, and run the motor without load as long as possible.

It is false economy to use brushes down to the absolute minimum length before replacement. Cases have been known where brushes have worn down until the metal, where the pigtail connects to the brush, was touching the commutator. This, of course, was causing severe damage to the commutator.

Make sure that each brush surface in contact with the commutator has the polished finish that indicates good contact, and that the polish covers all of this surface of the brush. Check the freedom of motion of each brush in the brush holder.

When replacing a brush, be sure to put it in the same brush holder and in its original position. It has been found helpful to scratch a mark on one side of the brush when removing it so that it will be replaced properly.

When installing new brushes, fit them carefully to the commutator. To do this, insert a strip of fine sandpaper, sand side up, between the commutator and the brush. Rotate the commutator back and forth, allowing the brushes to bear on the sandpaper only when the commutator is moving in the proper direction of rotation.

The brush should be lifted so it will not touch the sandpaper, on the back pull. Sand only until the curve of the brushes is the same as that of the commutator. Be sure that brush shunts (pigtails) are fastened securely so that current will not overheat the brushes and brush holders.

Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and excessive sparking. Excessive heating may have annealed the springs, in which case they should be replaced and the cause of heating corrected. Larger motors have means for adjusting the spring pressure, which should be 2 to 2½ lb. per sq. in. of area of brush contact with the commutator.

Inspect the commutator for color and condition. It should be clean, smooth, and a polished-brown color where the brushes ride on it. A bluish color indicates overheating of the commutator.

Roughness of the commutator should be removed by sandpapering or stoning. Never use emery cloth or an emery stone. For this operation, run the motor without load. If sandpaper is used, wrap it partly around a wood block.

The stone is essentially a piece of grindstone, known to the trade as a commutator stone. Press the stone or sandpaper against the commutator with moderate pressure with the motor running without load, and move it back and forth across the commutator surface.

Use care not to come in contact with live parts. If the armature is very rough it should be taken out and the commutator turned down in a lathe. When this is done, it is usually necessary to cut back

(*Continued on page 60*)

Check motor foot bolts and end-shield bolts every six months to make sure that they are securely fastened. Here is a good example of how *not* to do this—use wrench, not pliers; also observe safety rules.

Maintaining Controls—

THE NERVE CENTERS OF THE ELECTRICAL SYSTEM

By E. H. Alexander*

ANY equipment in daily use, and upon which industry depends for continuity of service, requires periodic inspection and maintenance. This is especially important when plants are running at peak capacity and when top production depends upon the continuous operation of each and every piece of equipment.

Electric control is no exception to this rule. After operating sometimes thousands of times a day, it is vitally important that controls be inspected regularly and that replacements or repairs be made quickly when necessary. Such inspection and maintenance pays big dividends by helping to keep up continuous production and by preventing costly shutdowns that waste the time of men and machines.

As in all operating equipment, prerequisites to any good maintenance program are the proper selection and installation of the equipment.

After the proper control has been selected for the job, the next important step is to install it correctly and make necessary adjustments before putting it into service.

Correct Installation Essential

Unpack the equipment carefully as small parts may be thrown away with the packing material. Mount the panel vertically, so that the contactors will open by gravity when power is cut off. Panels should be mounted on a flat surface, and care should be taken not to twist the back when mounting. Copper grounding terminals are provided on open controllers for connecting ground wires to the apparatus. The conduit connection to the cases of enclosed controllers is considered sufficient grounding protection.

The sealing surface of the magnet frame and armature is spread with grease or oil to prevent rusting in shipment. The grease or oil should be removed when the contactor is put into service, but the surface should be wiped occasionally with a thin, rust-resisting oil. Before power is applied, each contactor and relay should be operated by hand to see that the moving parts operate freely and without binding. All electric interlocks should be clean and should make good contact when closed.

Resistor boxes should always be mounted with the grids in a vertical plane, and should be so located that free ventilation is permitted. To keep heating at a minimum, it is recommended that six-inch spaces be used between boxes when stacked, and that the stacks be 12 inches apart. Such an arrangement is desirable when continuous or heavy intermittent duty is expected, and essential when boxes are stacked over six high. Slow-burning or noninflammable wire should be used in connecting to resistor terminals, to withstand the heat from the resistor.

Adjustment at Installation

Contactors are designed to operate properly if the line voltage is within 85 to 110 per cent of the panel nameplate rating for a-c circuits, and within 80 to 110 per cent for d-c circuits. Wider ranges require special devices.

Where there is a continuous 10 per cent increase in voltage, suitable coils should be ordered, because, with this increase in voltage there is an approximate 50 per cent increase in wattage, which greatly increases the heating of the coil. While this will not cause immediate failure of the coil, the deterioration of the insulation is more rapid and the ultimate life of the coil is shortened. There is also an increase of 20 per cent in the pounding effect, resulting in a more rapid deformation of the armature, crystallization of the magnet parts, breaking of the contact tips, and increased noise.

The armatures should seal when the proper voltage is applied to the coils and should open by gravity when the power is cut off. All contact tips should, when closed, make line contact near the bottom of the face. On opening, the final break will be near the top. The rolling and wiping motions when closing and opening keep the contacts in good condition.

Electrical interlocks are adjusted at the factory to make contact at approximately the same time that the main contactor tips touch, or even a trifle later. For some special applications the interlocks may make contact before the main tips touch but, in general, the above instructions apply. To change the adjustment, loosen the nuts on the front and back of the base and screw the stud in or out to suit the conditions.

Mechanical interlocks are so adjusted that, with one contactor in the sealed (closed) position, there is a very small play on the other contactor. This play must not allow the moving contacts of the second contactor to touch the corresponding stationary tips when the tips of the first contactor are just touching.

Preventive Maintenance

Now that the control device has been properly selected, installed, and adjusted, the maintenance program itself starts.

A first consideration in keeping control equipment in proper working condition is to prevent an accumulation of dirt, oil, grease or

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water on the operating parts of the control. It is, therefore, advisable to carry in stock protective paints for the stationary iron parts, and insulating varnish of the proper characteristics for the coils.

Where the air is saturated with moisture, or subject to the action of corrosive gases, it is well to inspect and paint the various control parts from two to four times a year, depending on the severity of operating conditions.

It is often desirable to add heaters or lamps within the controller enclosure to prevent condensation of excessive moisture. For best results, such heaters should be energized continuously, especially when the controller is not being used.

Circuit breakers or contactors are usually of very rugged construction. Still, it is best to operate them by hand from time to time and check to make sure that all of the clearances are normal and that parts are working freely. Should parts become worn so that adjustments cannot be maintained, new parts should be used. Adjustment and cleaning, as well as renewal of the tips, is necessary and depends on the frequency of operation of each device. In the case of contactors, for example, the armature should be cleaned and checked for free working and the condition of the magnet contact surfaces inspected.

Occasional inspection should be made of all nuts and connection wires on panels and resistors, particularly when subject to vibration. Close inspection of pigtail connections should be made periodically since these are of finely woven wire for flexibility. In extremely corrosive atmospheres pigtail connections have been known to fall apart before there was any apparent indication of failure.

Float switches should be given the best of care, especially if they are of the moving contact type. The tips should be adjusted and lined up properly and, of course, cleaned if any indication of excessive corrosion is noted. The bearings should be made free to operate and any tendency towards binding should be corrected immediately.

In float switches of the mercury contact type, the mercury tubes should be held tightly in place, and if inspection shows that the tubes are becoming dark, it may be an indication of air leakage and the tubes should be renewed.

Panels should be mounted vertically, so that the contactors will open by gravity when power is cut off. They should also be mounted on a flat surface and in a clean, dry spot if possible.

Trouble Shooting

Troubles are bound to occur in the best of control equipment. Knowing what to do about them when they do occur will save much precious production time. The remainder of this article will discuss some of the more common types of trouble which the maintenance force encounters with control devices, show the causes of such troubles, and explain how to stay one jump ahead of them. If the fundamental cause of each trouble is understood, the remedy will quite likely be apparent, and ways will be found to lessen the resultant trouble.

A contactor has several bolted or spring-closed contacts. Excessively high resistance at these contacts is the cause of the very high temperatures, such as 100 to 200 degrees C., that may be reached when the contactor is carrying rated current or less. The most likely point of high resistance is at the contact where the movable tip makes contact with the stationary tips.

However, high resistance may occur at any of the several bolted joints on the contactor. Therefore, if one of these devices begins to develop an excessive temperature, a millivoltmeter should be used to determine which of the several joints has a high-voltage drop across it. An a-c millivoltmeter is now available that can be used for checking the voltage drop on a-c contactors.

High Resistance Contacts

When the copper contact or contacts that have excessive drop across them have been located, correction can be made by opening the contact and removing the oxide with a file (not with sandpaper or carborundum paper). It is unusual to find a high resistance in a bolted joint unless the contactor has previously reached very excessive temperatures. However, when excessive resistances are found in joints the cause should be removed.

Since high resistance will most commonly be found in the active contact, it is a very simple matter to inspect these tips weekly or monthly. If the temperature is unduly high, the tips should be given a few strokes with a file.

The foregoing comments apply particularly to copper contacts because they oxidize readily, and the copper oxide formed has a very high resistance. A file will remove the oxide and reduce the resistance to a low value again. Depending on various conditions, it may take a short or long time for the formation of sufficient oxide to cause excessive heating under ordinary types of service.

However, if sulphur gas is present, a high-resistance film will develop quite rapidly. To prevent this action, the contactor should be mounted in a tightly gasketed enclosing case, or immersed in oil.

Sometimes it is not practicable to keep the resistance of contacts low by filing them. When it is desired or necessary to maintain a low resistance of the active contact without servicing, a silver face can be brazed to the two tips so that the contact is made through that metal. Silver will oxidize and the oxide has a higher resistance than the pure metal, but when heated, silver oxide has the unusual property of reverting back to the metallic form. Therefore, silver contacts are self-purifying.

Electrical interlocks may fail to make circuit because of oxidation where copper contacts are used. Sometimes such failure occurs because dirt gets between the contacts. By using one hemispherical and one flat tip made of silver, both of these troubles will be overcome. The point of the hemispherical tip will make contact without trapping dirt particles between it and the flat tip, and the use of silver will overcome the oxide trouble occasioned by oxidation when copper contacts are used.

Excessive wear on the contact tips of a contactor indicates that it is operated frequently. For conditions of this kind, silver should not be used for the contacts, because it does not have the ability to stand up under this severe service as well as copper.

If the service is unusually heavy, and if the root-mean-square of the current is not more than equivalent to three-fourths of the contactor's rating, the tip can be faced with a certain alloy that will last several times longer than copper tips. The cost of this material is quite high, but its use is sometimes warranted.

Let Contact Tips Stay Rough

Some maintenance men have the erroneous impression that contact tips that have been roughened by service should be kept smoothed up so that they will carry the load. A roughened tip will carry current just as well as a smooth tip.

Of course if a large projection should appear on a tip because of arcing it should be removed. However, a tip that has been roughened by ordinary arcing need not be serviced. If a copper tip becomes overheated, this condition indicates that oxide has developed and should be removed.

A large percentage of contactor coil troubles can be traced back to heating. Therefore, if the temperature can be reduced, coil troubles can be greatly decreased. Since the heating of a d-c coil will vary as the square of the voltage, and the heating of an a-c coil will vary about as the cube of the voltage, it follows that coils should be wound for the voltage that exists on the line. If the ambient temperature is high, this precaution is all the more important.

Preventing Coil Burnouts

When an a-c magnet, such as a solenoid, is supplied with constant-voltage excitation it requires a large inrush of current to close the armature. When the armature closes, the coil current drops to a normal value. Sometimes armatures may not close because of excess friction or for some other reason and the large inrush current may burn out the coil within a few seconds.

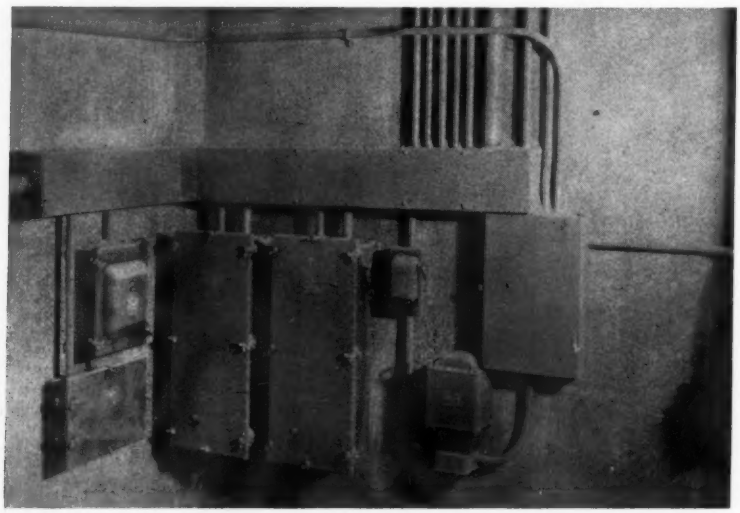
Such mishaps can be prevented by the use of a thermal cutout to protect the coils. When the thermal cutout opens because the armature fails to close, it is merely necessary to replace a small link made of two pieces of metal held together by solder.

Care of Resistors

Resistors are important auxiliaries and are encountered in many types, such as porcelain-tube, enameled resistors, open-wound, wire resistors, strip-wound, cast-grid, etc. Some types are more likely to develop certain kinds of trouble than others.

Cast grids are usually assembled and held together by being clamped on a tie rod. The current passes from one grid unit to another across a ground face. When too much current, say several hundred amperes, is made to flow across these ground surfaces, they may develop high resistance and destroy the joint.

To overcome this difficulty, these joints should be cleaned and the current path paralleled. This procedure will reduce the current in the middle joints, where the trouble usually occurs or is most likely to develop.



The surrounding atmosphere determines to a great extent the proper type of enclosure to be used. These starters are installed in a grain elevator, and are protected against dust by special dust-tight enclosures.

Edge-wound or strip resistors usually have their terminals either brazed or welded to the strip, which prevents excess resistance from developing at this joint. In order to provide an adjustable contact on this type of resistor, a clamp type of terminal is sometimes furnished. However, since the resistor may become quite hot at this point, a bad contact is very likely to develop. Therefore, if one does develop, the best cure is to braze the terminal at the proper position.

The high-resistance cast grids that have a small cross-sectional area sometimes give trouble because of breaking, especially if they are mounted on machines that vibrate severely. The best correction for this trouble is to use an edge-wound resistor, which is nonbreakable. This type is made of corrosion-resisting material that is capable of withstanding very high temperatures without scaling.

The function and importance of relays is too well known to need discussion here. To cover all the relays used would be an endless task because there are many varieties of them. A number of relays have been designed to operate as a function of time. The one that was designed first to operate on a time basis was the dashpot type. Movement of a solenoid is retarded by means of a dashpot, giving a time-current relation that is called an inverse-time characteristic.

The kind of trouble that is inherent in a dashpot was the primary reason for the development of the other types of timing relays. A dashpot is essentially a close-fitting device that is easily affected by dirt, gumming of the oil, and corrosion of the close-fitting parts. Also the torque of the magnets varies with the position of the solenoid armature in its coil.

If trouble is experienced due to tripping while starting a motor or shortly after getting up to speed, there are three things that can be done:

1. A heavier oil may be used if the relay almost holds.
2. A starting contactor can be used that does not include the overload relay in the circuit. After the motor is up to speed, the running contactor can close and the starting contactor can open, connecting the overload relay into the circuit. This is a rather complicated method, but it is sometimes used.
3. The final alternative is to replace the dashpot with a temperature type of overload relay. This is one of the reasons why the temperature-type overload relays were originally developed.

Replacing a movable contact on a 2300-volt motor control. Renewal parts should be kept handy at all times so that replacements can be made quickly.

Temperature Overload Relay

Since the function of a temperature overload relay is to protect a motor under all ambient temperatures, its final temperature should be the same as that of the motor—which is 90° C. This means that a motor can have a 50° C. rise in a 40° C. ambient.

Therefore, the relay should just trip if placed in a 90° C. ambient, or in a pail of water held at that temperature. If a relay does not function correctly, it should be immersed in a pail of water kept at 90° C. and adjusted so that it will. The adjustment should not be made by bending the thermoflex strip. If this method of checking or adjustment does not provide the necessary degree of protection to the motor, it can be assumed that the size of the relay heater is not correct.

A temperature overload relay does not need any such maintenance attention as outlined for dashpots, but its use does involve the observation of certain precautions. Since it is sensitive to temperature, it should not be put in a strong draft, such as that from a window or a circulating fan. If it is necessary to place it in such a position, it should be shielded by a cover.

Conversely, a temperature overload relay should not be located above a source of heat, such as steam pipes. In brief, the relay should be in an ambient temperature that does not differ greatly from that of the motor.

The third type of relay is used for controlling the rate of acceleration of motors and for many other functions where a short-time-delay is needed. In the escapement type of relay, a pendulum is used as the governing means, which makes it necessary to mount the relay in a definite position with respect to the motion of the pendulum.

(Continued on page 60)

When Bombs Begin to Fall!

The industrial electrician has an important responsibility in war-time plant protection

THE POSSIBILITY of air raids on the industrial plants of this country is real, even though conditions at the present time do not indicate that such raids could be made on a large scale. The problem of protection and defense of industry is quite different from the problem of civilian defense although in both cases there is a common objective: the protection of persons from injury, the safeguarding of property, and the maintenance of morale.

Proper cognizance of the dangers involved and advance preparations to cope with them will limit the damage to industrial plants during enemy attacks from the air. But experience in Great Britain has proven that properly drilled and trained personnel are required if damage is to be kept to a minimum.

Duties of Maintenance Group

In any organized plan of industrial defense against air attack, the maintenance personnel will have a most important role. A splendid code of recommended practices, giving particular attention to the functions of the maintenance personnel, has been developed by a committee of the American Foundrymen's Association. The rules and admonitions set up in this code may be applied with only minor changes to most industrial plants.

Excerpts from the "Code of Recommended Practices for the Protection of Life, Property and Production in the Foundry"*, relating particularly to the electrical services of industrial plants, are reproduced in the following paragraphs.

The plant maintenance group should be headed by a plant engineering chief. He should be thoroughly acquainted with the plant facilities and all utilities serving the plant; he should be capable of supervising the regular plant electrical, millwright, pipe and steam fitter, rigger and construction department crews.

The duties of the plant maintenance group are numerous and are concerned primarily with keeping the plant utilities in operation in order to fight fires and to see that the undamaged portions of the plant are kept operating and to limit the damage. This is especially important where continuous operation and processes are involved so that there will be no loss of or damage to the material, or to equipment.

This group is responsible for demolition, repairs and salvage work and clearing away wreckage.

All maintenance men who are called upon to make installations and repairs throughout the plant should be carefully checked as to their record and loyalty because these men have a more or less full run of the plant and many times work without supervision.

Strategic Facilities

The location of all outside utility services entering the plant should be known so that in cases of emergency the service may be shut off. This applies to electricity, industrial gas, water, central station heating and the like.

All main incoming substations and valve pits or houses should be kept under lock and key against tampering.

If the utility company only has the right of access to the substation main breakers or valves, and they will not give any authorized person in the plant the right of entry to the control equipment in case of emergency, the name, address and telephone number of the utility company supervisor having jurisdiction should be had so that contact may be made immediately in case of trouble.

The location of all main electrical breakers serving various power distribution lines within the plant should be known and identified as to the area served by the line. Also, all water and sprinkler shut-off valves or industrial gas valves controlling buildings or certain plant areas should be known and identified so that these facilities can be controlled in case of emergency.

Any other service such as oil oil lines, steam lines and the like should be checked and shut-off valves should be known and identified.

Tools and emergency equipment should be kept on hand and accessible for instant use. Power or hand-pulled trucks should be provided for getting the equipment to the job.

Equipment should include such demolition apparatus as gas cutting and welding equipment that might be necessary in case of wreckage.

Gas masks or respiratory protective equipment should be on hand for use in the event the maintenance crew has work to do around toxic gases, vapors or fumes. This protective equipment must be suitable for the types of toxic materials expected to be encountered.

Explosion-proof type of flashlights should be available in case the maintenance crew has to work in the presence of flammable or explosive materials and gases.

Any employees assigned to outdoor duties during a blackout or bomb raid, or that have to do with wrecking and demolition work should be provided with heavy metal helmets to minimize possibilities of injuries.

Guards and patrols that are required to patrol outside areas

*Copies of the complete Code, which has been reviewed and passed by the Office of Civilian Defense, are available from the American Foundrymen's Association, 222 West Adams Street, Chicago, Ill., at a price of $1.50 each.

should be provided with water repellent apparel so that the patrols will function at all times during wet weather.

Employees assigned to fire-fighting squads should be provided with protective clothing usually worn by firemen when fighting fires.

Depending on the fire hazards in the plant such as oil, solvents and other highly flammable commodities should determine whether or not to provide asbestos and fire-resisting apparel to certain of the fire-fighting crew.

Protecting Transformers

Installations of transformers in vaults constructed of masonry or concrete should be kept locked at all times against unauthorized entry.

Installations of transformers located in the open, either indoors or outdoors, should be completely surrounded by fencing at least eight feet high to the top strand of barbed wire.

As much space as possible up to ten feet should be kept between the transformer or other electrical equipment within the enclosure and the fence. Entrance to such enclosure should be kept under lock and key at all times.

All new power transformer installations and lighting transformers extremely vulnerable and important to the operations, should be made within masonry or concrete walls with due regard to minimizing the number of doors, windows, skylights and ventilators, to prevent acts of sabotage unless the modern type of metal clad or air-cooled units are installed or wherein all the equipment is protected against injury and external short circuits.

The openings such as doors, windows, skylights and ventilators should be so located or protected with barriers or baffles that the electrical equipment within cannot be reached with rods, water or other objects.

The utility company should be requested to make an inspection of the facilities serving the plant to determine if it has taken all the reasonable precautions against interruption in service and against acts of sabotage. The plant should also request such utilities to make an inspection of the plant with the idea of making recommendations for furthering the facilities within the plant. Most utility companies have received certain instructions regarding safeguarding their own operations and many times their experience is of value to their customers.

Wherever it is possible, and depending upon the kind of service rendered, particularly electric power service and also the importance of the operations, the utility company should be asked to provide service from two different substations or sources of supply to the plant so that in the event of failure of one of the systems, service may still be obtained from the other source and if possible, have the circuits enter the plant from different routes.

High tension and main distribution cables and all important underground ducts should have the manhole covers in all pits locked or fastened down by means of locks, bolts and screws, or by spot brazing the cover to the manhole frame in several places.

Whenever any bare bus bars, cables or electrical equipment are within reach of window, door, screen, fence, roof, ventilator or skylight so that metallic rods, chains or water can be thrown into them, barriers or baffles of at least No. 12 U. S. Gauge steel or asbestos cement sheets not less than 3/8-inch thick should be installed to deflect any objects thrown into them and thereby prevent short circuits and burnouts. The adequacy and extent of such protection necessarily should depend on the importance of the equipment and the local conditions and installation. It is well to ask yourself the question: "What can I do to damage the facilities without being noticed?" and then provide the safeguards.

Protection of Entrances

All gates and entrances through fences and buildings on the outside should be lighted so that the full, open area of the entrance is lighted with an average of 10-foot candles measured at ground level. Such light should be easily extinguishable in event of a blackout and replaced by lights not visible from the air.

If lighting is to be employed to light the property lines or such strategic areas as substations, engine rooms, boiler rooms and the like, the lighting should be so arranged as to shine down on the area to be illuminated with careful attention being given to locating the lighting so as to minimize the casting of shadows and thoroughly lighting the areas involved.

When lighting is used for this purpose, the intensity should not be less than 5-foot candles in the darkest spots to be protected, measured at ground level. Such light should be easily extinguishable in event of a blackout and replaced by lights not visible from the air.

Blackout Precautions

If a plant does not operate during the night hours or if the type of occupancy does not warrant blacking out the glazed area such as warehouses, store rooms and the like, emergency interior lighting should be provided so that no light will be perceptible from the outside and yet there will be a minimum of lighting inside in order to evacuate the occupants or to make patrols effective over the area.

Any type of emergency lighting to be employed should use as much of the present lighting equipment now installed and yet be effective in a blackout.

Mercury vapor, high intensity mercury and fluorescent lighting systems cannot be used as these types of lighting are not adapted to turning down the light intensity by voltage control. No light bulb should be discernible from above at an angle of 90° or less with the vertical.

If the general lighting system is of the Mazda filament type, a rheostat can be located in the main lighting circuit and the voltage dropped to the required dimness.

In a room provided with a separate lighting system for watch service, the regular shop lighting system can be turned off and a rheostat provided in the separate watch circuit and turned down to the required dimness.

If none of the present lighting systems can be used for providing a minimum of light during a blackout period, either of the two following methods may be adopted. In any case the lighting should be installed in main aisles and over strategic equipment and areas that should be kept under observation.

In either type of installation, the lamps should not be placed closer than the suggestions for lighting recommendations soon to be issued by the Office of Civilian Defense.

Do not locate lamps too close to windows; place them opposite pilasters or other obstructions.

The Office of Civilian Defense will shortly issue specifications for lighting recommendations for emergency lights to be used in buildings with normal ceiling heights.

No attempts should be made to mount any emergency lighting in high vaulted rooms or rooms served with high overhead cranes because any lighting that would be effective at floor level would be too brilliant.

In such cases it may be possible to mount lights from the wall or columns at normal height or even install portable lights mounted on floor stands provided suitable reflectors are used.

Emergency lighting can also be used consisting of 2 or 3 watt neon glow lamps without reflector installation.

If such lighting is provided, it is imperative that the glow lamps be installed at least six inches above the top of the highest window in the room.

This type of lighting is somewhat different from the light obtained under reflectors in that the light gives a silhouette effect to objects between the light source and the observer.

Signs or directional indicators can be made by using a 1/2-watt neon glow lamp inside a box or other receptacle so that the light shows through the cut out portion of the face of the sign.

The face of the sign should be protected from being seen from above outside the building and such signs should not face clear windows.

The lamps specified in the foregoing can be obtained from most any lamp manufacturer and will work on alternating or direct current.

Even the dimmest of lights may reflect out of doors through windows and wall or roof openings from the surface of liquids in containers within, or from highly polished or mirror finish machined surfaces on tools, equipment or product. Steps should be taken to cover over any surfaces that cause reflection.

If emergency lighting is employed, the building should be carefully checked at night from the outside to make sure of the effectiveness of the subdued lighting system and should also be checked for reflected light.

During a blackout period, all

(*Continued on page 58*)

Preheating Process Improves Insulation Characteristics

By George C. Borthig*

THE MOISTURE present in cotton and paper insulation represents a potential hazard to the motor coils or other equipment insulated with these materials, even though they have been treated with insulating varnish. To eliminate the danger to insulation resulting from this moisture content, insulating varnish manufacturers have advocated the use of the preheating method.

This is a system of preheating the untreated unit to a temperature above 212° F. for a length of time judged to be sufficient to remove the moisture present. This time is naturally dependent upon the amount of cotton and paper insulation present and is also governed by the size of the unit. The preheating of the units also assures complete evaporation of the varnish solvents. These two factors aid considerably in the development of better electrical insulation.

Preheating Increases Effectiveness

Not only does this preheating remove any moisture present in the organic material of the coil but it aids in the penetration of the varnish. This is accomplished through the natural transfer of heat from the preheated unit directly to the varnish. The viscosity of the varnish in the immediate vicinity of the hot coil is lowered by this heat, resulting in a thinner varnish which will flow into the coil more readily. Another factor contributing greatly to better absorption is the fact that during this transfer of heat from the coil, a contraction of the air present in the coil takes place thus creating a natural partial vacuum and inducing greater varnish penetration.

In order to secure maximum varnish penetration, the vacuum impregnation method of treatment is often employed. In this method, units are first preheated to remove moisture present and then placed in a vacuum chamber which is evacuated.

The varnish is then drawn in, totally submerging the coils, and they are then allowed to remain submerged for a period of time dependent upon the depth of the winding and the size of the wire. If pressure is required, it can be introduced through the medium of a pressure pump and can be maintained until thorough impregnation is accomplished. This safe and simple process is known as the "varnish pressure method."

Since insulating varnishes usually contain extremely volatile solvents which form explosive mixtures when combined with air, it is safer to use an inert gas as a means of applying pressure. For that reason, compressed carbon dioxide or other inert gases are employed in the application of pressure to vacuum impregnation units.

One of the most important advances in the chemistry of insulating varnish was the development and adoption of the use of tung oil in both the clear and black types of insulating varnish. This oil, long known to old China, imparted to insulating varnishes waterproof qualities which have not been equalled or surpassed to the present date. Because of ideal climatic conditions, tung trees are being cultivated successfully in some of the southern states. The oil from these trees is superior in quality to the Oriental grades. Because of the modern processing, the American oil is free from impurities and is more uniform, an important factor in insulating varnishes.

The demand for a faster curing varnish to meet ever increasing production demands as well as a need for an insulating material for use with the newer types of Class B insulation such as Fiberglas and asbestos covered wire led to the development and subsequent adoption of the synthetic resin base insulating varnish.

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Some of these varnishes may be considered gum solutions, yet when they are baked out, and after the solvent has been evaporated, a chemical change takes place which produces a material entirely different from the old type of gum deposit or residue. Besides the curing taking place through heat action, there is also some oxidation of the oil present in the oleo-synthetic resin type of product. The hardness or drying produced by some of the synthetic varnishes in deep wound coils is far superior to that obtained with the conventional type of insulating varnish.

These various synthetic resins permitted the formulation of insulating varnishes to meet such requirements as acid and alkali resistance, heat conductivity, high dielectric strength, penetration, bonding strength, solvent releasing properties and, in some cases, the ability to remain intact at speeds up to 25,000 rpm developed in small armatures. This latter characteristic was made possible by the non-themoplasticity of the varnish when properly baked.

(*Continued on page 59*)

*Maintenance Check Chart for Electrical Apparatus**

Motors

(1) Keep windings, ventilating ducts, commutators and brush rigging clean. In dusty locations, blow out weekly; under severe conditions, daily. Do not use air pressure higher than 50 lbs.

(2) Lubricate regularly, carefully. Follow manufacturer's instructions. Oil daily those motors that require it. Schedule definite oiling dates for the others. In dusty or damp locations, drain oil once a month and renew. Do not over-lubricate. It wastes oil, gets in windings and deteriorates insulation.

(3) Examine bearings. Check daily on heavily used motors; once a week on others. Check oil ring. Feel for high temperatures. Check for excessive end play.

(4) Check air gap between the rotor and the stator. Check weekly on motors that operate with excessive belt tension; others, once a month. Differences in width of gap indicate bearing wear which, once started, accelerates rapidly.

(5) Inspect brushes and commutators. Check daily on those motors in severe service; others once a week. Keep commutators smooth, with brushes seated perfectly. On carbon brushes use correct grade to prevent excessive commutator wear and control arcing.

(6) Inspect all exposed motor leads. Check weekly, keep connections tight, free from oil and moistures, well insulated and protected.

(7) Inspect ground connections. Check weekly, keep tight in a good condition. These are important to safety of employees and, in some cases, of current protective devices.

Control Equipment

(1) Keep control equipment clean. Once a week, clean and blow out dirt and dust from starting switches, compensators and air circuit breakers. Under unusually clean conditions, clean out quarterly or semiannually. Keep dirt and dust off high voltage bushings and terminals.

(2) Keep contacts smooth. Inspect heavily used equipment weekly, others once a month. File burned contacts smooth or replace. Do not lubricate contact surfaces.

(3) Replace worn parts. Under severe conditions examine all equipment monthly and replace all worn or burned parts; under normal conditions, semiannually. Keep adjustments correct.

(4) Keep electrical and mechanical connections tight. Once a week inspect parts that vibrate. Look for loose connections, missing or loose nuts, and broken mechanical parts.

(5) Keep oil at proper level and in good condition. Under severe conditions or in dirty or damp locations, make a monthly check of oil condition and oil level. Replace dirty or gummy oil. Keep level up to indicator.

(6) Check overload devices. Circuit breaker tripping points should be checked monthly. Replace dashpot oil if thick and gummy. Keep orifices in plunger clear. Keep leather bellows soft and pliable with neat's foot oil. Be sure that heater coils for thermal overload relays are the correct size. Check overload relay settings every six months.

Lightning Arresters

(1) Maintain ground connections. Inspect in early spring before the start of the lightning season. Check the condition and resistance of ground connections. Resistance should not be over 5 ohms. A buried water main provides good ground. Never run ground wire through iron or steel pipe unless wire and pipe are bound together.

Wiring

(1) Keep wiring in safe condition. Examine monthly where vibration exists. Keep lock nuts and bushings tight on conduit, cables and other raceways. Protect wire from oil and water. Keep open wiring tight, insulated and safe from mechanical injury. Inspect all wiring once a year.

(2) Check extensions and drop cords. Examine every three months where use is heavy. Check closely where wire enters socket, plug, switch, etc. Replace or repair excess wear promptly. Keep drop cords away from nails, metal hooks, etc. Keep lamp guards in place.

(3) Keep switch, junction, fuse and panel boxes clean and tightly covered. In dusty locations clean out weekly. Keep covers and unused "knockout" plugs in place. Inspect monthly.

Fuses

(1) Check size. Twice a year inspect all fuses to determine that circuits are not overfused.

(2) Keep fuse clips clean and tight. Check connections to prevent overheating and breakdown.

(3) Maintain refillable type fuses. Replace charred casings. Keep fuse assembly tight. Refill with links at the same rating as the casing.

(4) Keep fuse and switch cabinets tight. Prevent escaping sparks when fuses blow by plugging unused knockouts. Always keep doors tightly closed and secured.

Transformers

(1) Keep oil in good condition. Test annually to determine dielectric strength. If less than 18 kilovolts in standard tester, recondition oil.

(2) Maintain oil and proper level. Check oil level every three months. Replace leakage and evaporation loss promptly.

(3) Prevent excessive temperatures. Test operating temperatures of fully loaded transformer once a month. Temperature should never exceed 90° C.

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*A pasteboard maintenance check chart, 16½x21½ inches, covering the foregoing, for posting on plant bulletin boards is available upon request to Department 7 N Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Maintenance Check Chart for Commutating Equipment

THE maintenance of satisfactory performance of commutating equipment* necessitates watchfulness and care on the part of the operator. This is especially true at times such as these when heavy production schedules, long hours and peak loads place an added burden on all power equipment. Commutators in poor condition should be re-surfaced at the first opportunity, carefully inspected for feather-edge mica, if undercut, and kept in good condition by daily application of a canvas wiper.

At the first indication of unsatisfactory performance the cause should be sought and the faulty condition corrected before serious damage is done.

Some potential sources of operating difficulties can be detected before trouble occurs. Others are less evident and the first indication of their presence appears in some such form as imperfections of the commutator surface, visible sparking, excessive heating or brush noise. This article discusses these indices of faulty machine or service conditions, together with the determination of the primary fault from which they result. The same fault may give more than one indication of its presence, or the first indication to appear may itself cause others to follow. For example, sparking may be the immediate cause of poor commutator surface and that, in turn, lead to noisy operation which can be permanently relieved only when the primary cause of sparking has been determined and eliminated.

There is of necessity, therefore, considerable overlapping in the discussion of these readily detected indications of less obvious faults.

Analysis of Cause and Effect

The number of primary faults from which poor brush performance may result is large. This often makes it difficult to determine the primary source of trouble in a specific case. The problem can be simplified to some extent by systematic analysis of the symptoms in the following manner.

In the following table, Primary Sources of Unsatisfactory Brush Performance, is given a list of some of the more common sources of unsatisfactory brush performance. These include preparation, care and adjustment of the machine, mechanical and electrical faults, design characteristics, load, service and external conditions, and brush grade. Each item in the list is numbered for reference purposes in the table which follows.

The latter table, Indications of Unsatisfactory Brush Performance, lists in the subheadings some of the more common faults appearing at the brushes, at the commutator surface, and as heating in various parts of the machine. Under each subhead is a list of immediate causes of these faults. The numbers immediately following refer to the table of Primary Sources of Unsatisfactory Brush Performance. They either define the immediate cause in specific terms or give the source from which it may arise.

In many cases a large number of primary faults are listed as possible sources of a particular indication of unsatisfactory performance and the table may seem to offer little aid in the search for the specific fault involved. However, there is usually more than one indication of a faulty condition. If the primary faults usually responsible for each of these indications are noted and those selected which are common to all observed indications, the probable sources of trouble will be greatly reduced in number and the isolation of the existing fault thereby simplified. For example, more than 40 faults are listed as probable sources of sparking. However, should there be etching or burning of the commutator bars without flashovers having been experienced, the list of probable faults is reduced to 8. A tendency toward streaking or threading of the commutator would further reduce this list to No. 2 and No. 3, indicating high or "feather-edge" mica to be the most probable source of the trouble.

It is impracticable to attempt to include in the tabulation here presented all indications of unsatisfactory conditions and all primary faults from which they may result. The list presented, however, supplemented by other items gleaned from experience, offers a systematic method for diagnosing a case of poor brush performance and determining the underlying cause.

Primary Sources of Unsatisfactory Brush Performance

Preparation and Care of Machine

1. Poor preparation of commutator surface
2. High mica
3. Feather-edge mica
4. Bar edges not chamfered after undercutting
5. Need for periodic cleaning
6. Clogged ventilating ducts.

Machine Adjustment

7. Brushes in wrong position
8. Unequal brush spacing
9. Poor alignment of brush holders
10. Incorrect brush angle
11. Incorrect spring tension
12. Interpoles improperly adjusted
13. Series field improperly adjusted

Mechanical Fault in Machine

14. Brushes tight in holders
15. Brushes too loose in holders
16. Brush holders loose at mounting
17. Commutator loose
18. Loose pole pieces or pole face shoes
19. Loose or worn bearings
20. Unequal air gaps
21. Unequal pole spacing
22. Dynamic unbalance
23. Variable angular velocity
24. Commutator too small

Electrical Fault in Machine

25. Open or high resistance connection at commutator
26. Poor connection at shunt terminal
27. Short circuit in field or armature winding
28. Ground in field or armature winding
29. Reversed polarity on main pole or interpole

*This material has been adapted from publications of the National Carbon Company, Inc., Cleveland, Ohio, on the correction of unsatisfactory brush performance.

Machine Design

30. Commutating zone too narrow
31. Commutating zone too wide
32. Brushes too thin
33. Brushes too thick
34. Magnetic saturation of interpoles
35. High bar-to-bar voltage
36. High ratio of brush contact to commutator surface area
37. Insufficient cross connection of armature coils

Load or Service Condition

38. Overload
39. Rapid change of load
40. Reversing operation of non-interpole machine
41. Plugging
42. Dynamic braking
43. Low average current density in brushes
44. Contaminated atmosphere
45. "Contact poisons"
46. Oil on commutator or oil mist in air
47. Abrasive dust in air
48. Humidity too high
49. Humidity too low

Disturbing External Condition

50. Loose or unstable foundation
51. External source of vibration
52. External short circuit or very heavy load surge

Wrong Brush Grade

53. "Commutation factor" too high
54. "Commutation factor" too low
55. Contact drop of brushes too high
56. Contact drop of brushes too low
57. Coefficient of friction too high
58. Lack of film forming properties in brush
59. Lack of polishing action in brush
60. Brushes too abrasive
61. Lack of carrying capacity

Indications of Unsatisfactory Brush Performance*

Indications Appearing At Brushes

Sparking:

Commutator surface condition; see 1, 2, 3, 43, 44, 45, 46, 49, 58 and 59.
Over-commutation; see 7, 12, 31 and 33.
Under-commutation; see 7, 12, 30 and 32.
Too rapid reversal of current; see 7, 12, 30 and 32.
Faulty machine adjustment; see 8, 9 and 11.
Mechanical fault in machine; see 14, 15, 16, 17, 18, 19, 20, 21 and 22.
Electrical fault in machine; see 25, 27, 28 and 29.
Bad load condition; see 38, 39, 40, 41 and 42.
Poorly equalized parallel operation; see 7, 13, 23 and 34.
Vibration; see 50 and 51.
Chattering of brushes; see "Chattering or Noisy Brushes."
Wrong brush grade; see 54, 56 and 58.

Etched or Burned Bands on Brush Face:

Over-commutation; see 7, 12, 31 and 33.
Under-commutation; see 7, 12, 30 and 32.
Too rapid reversal of current; see 7, 12, 30 and 32.

Pitting on Brush Face:

Glowing; see "Glowing at Brush Face."
Embedded copper; see "Copper in Brush Face."

Rapid Brush Wear:

Commutator surface condition; see specific surface fault in evidence.
Severe sparking; see "Sparking."
Imperfect contact with commutator; see 11, 14, 15, 16, 50 and 51.
Wrong brush grade; see 53 and 57.

Glowing at Brush Face:

Embedded copper; see "Copper in Brush Face."
Faulty machine adjustment; see 7 and 12.
Severe load condition; see 38, 39, 41 and 42.
Bad service condition; see 46 and 47.
Wrong brush grade; see 56, 60 and 61.

Copper in Brush Face:

Commutator surface condition; see 2 and 3.
Bad service condition; see 43, 46, 47, 48 and 49.
Wrong brush grade; see 58 and 60.

Flashover at Brushes:

Machine condition; see 14 and 35.
Bad load condition; see 38, 39, 41 and 52.
Lack of attention; see 5 and 11.

Chattering or Noisy Brushes:

Commutator surface condition; see specific surface fault in evidence.
Looseness in machine; see 15, 16 and 17.
Faulty machine adjustment; see 10 and 11.
High friction; see 43, 45, 49, 51, 57 and 58.
Wrong brush grade; see 54, 57 and 58.

Brush Chipping or Breakage:

Commutator surface condition; see specific surface fault in evidence.
Looseness in machine; see 15, 16 and 17.
Vibration; see 51.
Chattering; see "Chattering or Noisy Brushes."
Sluggish brush movement; see 14.

Indications Appearing at Commutator Surface

Rough or Uneven Surface:
See 1, 2, 3, 4 and 17.

Dull or Dirty Surface:
See 5, 44 and 59.

Eccentric Surface:
See 1, 19, 22 and 51.

High Commutator Bar:
See 17.

Low Commutator Bar:
Sparking; see 2 and 25.

Streaking or Threading of Surface:
Sparking; see 43, 44, 45, 46, 49 and 58.
Copper or foreign material in brush face; see 2, 3, 46, 47, 48 and 60.
Glowing; see "Glowing at Brush Face."

Bar Etching or Burning:
Sparking; see 2, 3, 7, 12, 30, 31, 32 and 33.
Flashover; see 5, 11, 14, 35, 38, 39, 41 and 52.

Bar Marking at Pitch Spacing:
Sparking; see 25 and 37.
Sparking; see 7, 12, 30, 56 and 59.

Flat Spot:
Sparking; see 19, 23, 25, 41, 42 and 52.
Flashover; see 5, 11, 14, 35, 38, 39, 41 and 52.
Lack of attention; see 1, 5 and 11.

Discoloration of Surface:
High temperature; see "Heating—At Commutator."
Atmospheric condition; see 44 and 46.
Wrong brush grade; see 59.

Raw Copper Surface:
Embedded copper; see "Copper in Brush Face."
Bad service condition; see 43, 45, 47 and 49.
Wrong brush grade; see 58 and 60.

Rapid Commutator Wear with Blackened Surface:
Burning; see 2, 3, 11 and 14.
Severe sparking; see "Sparking."

Rapid Commutator Wear with Bright Surface:
Foreign material in brush face; see 43, 45, 47 and 49.
Wrong brush grade; see 60.

Indication Appearing As Heating

Heating in Windings:
Severe load condition; see 38, 41, 42 and 52.
Unbalanced magnetic field; see 18, 19, 20, 21, 27, 28 and 29.
Unbalanced armature currents; see 8, 19, 22, 25, 27, 28, 29 and 37.
Poorly equalized parallel operation; see 7, 13, 23 and 34.
Lack of ventilation; see 6.

Heating at Commutator:
Severe load condition; see 38, 41 and 42.
Severe sparking; see 7, 8, 9, 12, 20, 33, 45 and 56.
High friction; see 10, 11, 36, 43, 45, 49, 57 and 58.

(Continued on page 58)

*The boldface headings refer to the indications of unsatisfactory performance. Immediately beneath each indication of unsatisfactory performance are listed the probable immediate causes. The numbers listed after each immediate cause refer to the probable primary faults given in the table "Primary Sources of Unsatisfactory Brush Performance."

Can Service Pay Its Way?

By L. K. Baxter*

FREEZE orders, curtailment rulings, and manufacturers' production "end dates" have brought with them the shocking realization that the merchandise you sell—have depended on for years for your livelihood—is no longer available. This is a staggering blow that can't be shaken off lightly. There are no panaceas or cure-alls that can be applied to your problem. There's no easy answer, but a solution can be worked out by careful analysis, intelligent planning and organizing, and with plenty of hard work.

First, the question, "Can I make a profit with no new appliances available to sell?" must be answered.

Upon this answer depends your future — investigate, analyze, get the facts. Plan your business around this new set of conditions, then re-analyze and re-build again and again until you are positive of your stand. Don't just gloss over the situation or be satisfied with wishful thinking and merely put off the inevitable day of reckoning.

Stay in Appliance Business

Here are five reasons why you should continue in the appliance business:

(1) The pattern of the business fits you well and you fit well into the business. It's the thing you know best.

(2) You have spent large sums of money in making your name synonymous with electric appliances in your town. If you go out of business, you will lose part or all the value of your past advertising and selling effort. Remember the time is coming when there will again be appliances to sell.

(3) When you start selling in the post-war market you will need in your community hundreds of satisfied service customers to buy your new merchandise. The dealer that handles service during the war period will be in position to know of every person who has an old or antiquated appliance that is ready for replacement. Nothing is more important in building a sound foundation for future sales.

(4) Service can be made to pay its way, yet many dealers will tell you there is no money in the service business. But, if you ask ten dealers what they mean by "no money in the service business," you will receive ten different answers. This is just another way of saying that many do not know their service cost, because very few have ever kept a separate record on this part of their business. Many gave away service as a means of promoting their sales. As a consequence, of course, service could show no profit. Times have changed—people are ready and willing to pay for services rendered. Dealers should not overcharge, but should not at all feel reluctant about charging what the job is worth. To make a profit in this end of the business, a volume must be developed. It will be necessary that a dealer service all the available makes of appliances in his locality. If he does this, he can, through meter counts and saturation figures of utilities, estimate the potential service available in his locality. In addition to the appliance service, there is a tremendous service volume in repairs to lamps, sockets, plugs, etc.

(5) Handling used appliances offers an opportunity—the dealer should take advantage of this through his service department. By taking in used appliances, not requiring excessive rebuilding, he can add to the profit of his service department operation. Many dealers are doing this successfully today.

Yes, the dealer should stay in business wherever the potential service to be obtained in his locality shows there is sufficient volume available to justify it. It is true that the service business may not be as glamorous as selling new merchandise. There are no big profits to be made from it, but it can be a "bread and butter" business if handled properly.

Analyze Your Service Operation

The fact that there is sufficient service volume available in a community means very little unless it can be handled at prevailing service rates efficiently enough to produce a reasonable profit.

Many times it is helpful to use a self analysis sheet to cover the points in your service operation. A self-checking, step-by-step analysis often leads to the elimination of wasteful or inefficient operations or points out things that should be done, and thus lowers costs and increases profits. As a suggestion, review the accompanying self analysis quiz on service. Grade yourself sincerely and conservatively. There are 50 points. If your answer is "Yes" to every question, you are certainly doing a good job on service. Take off two points for each question where your answer is "No," and see how you score. This analysis will point up things you can do to improve your operation.

If you score well in this self-analysis, you are ready to consider immediate expansion of your service operation. If you have scored poorly, set out immediately to get your service "house" in order.

Determine Potential Volume

What is your service dollar volume now? Add to this your esti-

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*Mr. Baxter is manager of merchandise service for Westinghouse Electric and Manufacturing Company, Mansfield, Ohio.

Appliance Dealer's Self-Analysis Quiz on Service

(Answer questions yes or no in space provided.)

(1) Do you now provide all service for appliances you sell? ———, for other makes? ———

(2) Do you do a good job? ———

(3) Is your present location a good one for service?———

(4) Should you move to a lower rent location?———

(5) Do you have enough service men?———

(6) Do your service men work on all appliances?———

(7) Are your men neat and courteous?——— Are they new business producers?———

(8) Are your service men fully qualified for service work? ———

(9) Have you ever attended manufacturer's service schools? ——— Have your men? ———

(10) Are you using the manufacturers' training programs? ———

(11) Are you on the manufacturers' mailing list for service information?———

(12) Is your shop neat and efficient?———

(13) Do you have general shop tools?——— Power tools? ——— Specialized tools to do specialized work?———

(14) Is your stock of parts adequate?——— Are parts stocked in an orderly way and easily found?———

(15) Do outside men carry parts stocks in their cars?———

(16) Are these properly controlled?———

(17) Is your system for stock-out items simple and effective for reordering?———

(18) Do you have a perpetual inventory system for your parts stock?———

(19) Do you operate a "call for and deliver" system?———

(20) Are customers asked to bring in and take home those items that can be carried?——— Do you explain that this reduces the service charge?———

(21) Do you have an inventive salary plan or a profit sharing plan for your men?———

(22) Are standard factory service charges used?——— Do these charges meet competition? ———

(23) Is an adequate margin provided by these charges?———

(24) Do you have a trade-in plan for used appliances?———

(25) Are trade-ins priced so that they return an adequate profit?———

(26) Is your identity as a service outlet well established? ———

(27) Are your trucks properly labelled to advertise service? ———

(28) Are your service men's uniforms used to advertise service? ———

(29) Is your shop identified for service by decalcomania and other signs?———

(30) Have you a telephone directory advertisement for service?———

(31) Do you follow the practice of placing identification stickers on appliances in homes where you have rendered service?———

(32) Have you instructed your service men to ask customers for other repair jobs?———

(33) Is newspaper advertising used for service?———

(34) Have you tried telephone canvassing for service work? ———

(35) Are mailing pieces used to promote service?———

(36) Have you made house to house canvasses for service work? ———

(37) Are any service specials offered?———

(38) Are you sure you know just how much free service you are rendering?———

(39) Have you an adequate record of the paid-for service you are rendering?———

(40) Do your records truthfully show the profit derived from service?———

(41) Is your system for dispatching service men a good one? ———

(42) Are you offering any finance plan for service where needed?———

(43) Is your accounting and records system simple and efficient?———

(44) Is there a daily report of dollar volume for each service man?———

(45) Do you have a plan for increasing the dollar volume of low volume service men?———

(46) Have you made an analysis of your local market to determine the potential in appliance service? ———

(47) Is the assistance of manufacturers or distributors being asked for in the case of specific service problems?———

(48) Are you aware that some manufacturers have complete service plans available to help the dealer?———

(49) Have you made a thorough study to determine how much your service business can be increased through intense service promotion?———

(50) Are you willing to undertake the aggressive program that will be needed to provide the service volume necessary for continued operation?———

What's your total score

Yes——— **No**———

mate of the amount of service business you have given away, and for which you should have charged, then you will have some idea of the volume you should now be doing.

You have the problem of estimating just how much you can increase your service business. If you have already been promoting service, you may not be able to increase your volume very much by additional promotion. But if there is room for improvement through proper promotion, house-to-house canvassing based on the use of saturation figures and meter counts—arrive at the volume you can do if you "go all out" for service.

After you have arrived at an estimate of your potential, break it down into two classifications—outside major appliance service calls, and inside shop service operations. The outside calls should be placed on a flat rate charge for the first hour and so much for the second, and succeeding hours. These flat charges will vary considerably in different localities, depending upon labor rates, local competition, etc. Inside minor appliance service should be placed on a flat charge rate—these suggested rates are available from some manufacturers. This rate structure must include all overhead, costs, etc., and produce a reasonable profit.

Next, look into your service organization. How can you estimate the amount of service work that one service man can do? It depends pretty much upon the man, as you know service men differ in their ability to perform. Can they handle 10 outside major appliance calls per day, or 15 to 20 inside repairs per day? If your records show, or if you can estimate from your past experience how much a man can do per day, you can easily figure how many men are needed to accomplish the quota you have set.

After the amount of service available has been figured — so much minor, at flat charges, and so much major, at flat charges, you will know your potential dollar volume. From this, you deduct your free service and you have your net dollar volume.

Analyze Your Costs

Next analyze your costs. Review what office help is required. In many instances, a member of the dealer's family may be all the office help that is required, and again, other provisions will have to be made.

Transportation must be considered, and the question as to whether it is more economical to own this transportation or to contract for needed transportation or rent it, must be thoroughly analyzed, and the most economical method used.

Shop equipment must be considered—how much is available and what is the minimum that can be used and still perform service work economically. It will usually be found that machine tools reduce costs. They need not be expensive, but of the really essential types needed to perform the work. A list of these tools can be obtained from most manufacturers covering their equipment. A list of general shop equipment includes the following tools:

General Shop Equipment

1 ten foot repair bench
1 small drill press
1 set of drills (29 drills in rack)
1 bench vice
1 buffer-grinder
4 screwdrivers (graduated sizes)
1 pair of long nose pliers
1 pair of electricians' pliers
1 medium ballpeen hammer
1 kit of socket wrenches
4 files assorted
1 gum paper cutter
1 roll of gum tape
1 wrapping paper rack
1 roll of 24" wrapping paper
1 small oil can
1 hack saw
1 hack saw blade
1 claw hammer
1 crescent wrench
1 flashlight
1 trouble lamp
1 set of taps and handles

Through your accounting system you know your net dollar volume and must deduct the cost of your service men's salaries, office help and other indirect charges, rent, heat, light, taxes and all the other expenses of doing business.

Now, with this figure of what the available service is and based on your cost of doing it, you must budget your operations. This analysis may bring to light the need for adjustments. Possibly your location is too expensive. It may mean that you will have to move to less expensive quarters.

After your situation has been analyzed and if your decision has been made to continue in the business through rendering service in your territory, many promotional helps can be obtained from manufacturers to assist you. Some manufacturers provide field people to help you. Take full advantage of all the assistance available to you.

Service is now in the limelight. Everything you see — everything you read, is slanted toward keeping them running. Many stories come to us about the unprecedented volume of service work now available, but securing this business requires the same intense selling, promotion and follow-up that you so successfully employed in the sale of new merchandise.

There will be a day of peace —maybe in one year or two years —or perhaps three, four or five. Production of consumer goods will start again, and there will be a vast market for household appliances — bigger and better than ever. Many consumers will have worn out their ranges, refrigerators, irons and other appliances, and there will be a big back-log developed in the replacement market field. Many families that have gone together due to housing shortages, military service, etc., will spread out again, creating many new homes and a need for the goods you sell.

There will be a great abundance of power when the war production plants stop turning their wheels — power way beyond the needs of industrial plants manufacturing peace-time materials — power that will then be available in greater quantities than ever before for the residential user. Aggressive promotional programs embracing all phases of specialty selling and merchandising will once again be drawn into action.

Consumers will have all of their present debts paid and healthy savings in war stamps and bonds. It is predicted by the best informed merchandisers in the country that the ten years after the war will offer greater merchandising opportunities than have existed up to this time.

To insure your place in that merchandising business, you must be ready — your house must be in order — your reputation must be good — your plans must be sound.

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Mr. Baxter will discuss another phase of the appliance dealers' problems in a second article which will appear in a future issue of ELECTRICAL SOUTH.

Dealer Essential No. 1: Reduce the Overhead

A GOOD DEAL of courage was required to reduce an electrical appliance business operating four stores and doing a volume of $325,000 to one small store with four salesmen where fifteen were used before. However, that's what Oliver Radford, president of Oak Appliance Company, of New Orleans, La., has done — and he feels that it is the only practical means of "staying in the appliance business" for the duration of the war.

In business since 1936, Mr. Radford has built up a long customer list in the Crescent City, and a lot of goodwill which he doesn't want to see go by the board. "Putting in substitutes or closing up my business would simply mean that I would have to start out all over again," he said. "Something which I don't propose to do. I want to keep my customers thinking of me, and to hang on to the electrical appliance business because that's the only business I know. Although we have considered substitute lines seriously, to my mind the only logical way to maintain my business is to reduce overhead to an absolute minimum, and to go over to an exclusively cash business dealing in reconditioned used appliances."

How Business Stood Before

Mr. Radford's business in the past has been 60 per cent domestic appliances, 40 per cent commercial refrigeration such as display cases, reach-in coolers, etc. Last year, operating four stores in three large residential areas, and another on famed Canal Street in downtown New Orleans, he sold 800 refrigerators and a commensurate volume in all other appliances. This volume was sold against a monthly overhead of approximately $5,400, including $500 per month in rent. Fifteen salesmen were on the payroll, with drawing account and commission, and there was a large staff of service mechanics, deliverymen, and office personnel amounting to a payroll of $750 per month. Much of this latter overhead, of course, was necessitated because Oak Appliance Company handled a huge amount of credit business involving the use of bookkeepers, credit and collection men.

When the curtailment of some lines and shortages in others made it apparent late last year that the organization above was facing dissolution, Mr. Radford went to work on a possible solution. He visited other dealers, studied trade publications and wrote to dealers operating appliance businesses of similar size elsewhere. A month of this indicated to him that the logical "out" was the cutting of overhead, and the development of an extremely liquid business consisting of cash buying and selling of used appliances—which is the basis on which Oak Appliance Company is now operating.

It took two months to cut the Oak Appliance Company down to its present size. First, Mr. Radford let go eleven of his fifteen salesmen (many were already in the draft or ready to take defense jobs), retaining four men only, one of whom sells commercial equipment exclusively. These four men are now being paid a salary of $40 a week plus a 5 per cent commission on all business over a $1,500 monthly quota. "I made a mistake at first by telling them that they would receive a straight commission," Mr. Radford said.

Salary Improves Morale

"I found immediately that this lowered morale and involved resentment. By changing to the $40 a week system, I am getting the best possible salesmen, and am in a position to demand good selling. A good salesman can get $95 for a used refrigerator where a poor man will get $75, and thus although I am paying the highest salary in the local trade, I will get it back in better salesmanship." Since Oak Appliance Company merchandise will be almost entirely used equipment, Mr. Radford is convinced that it takes a better salesman to handle the same amount of business.

Having closed up all stores except for the best located Canal Street branch, Mr. Radford moved his office and sales force to this location. The store interior was remodelled, moving offices to the

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Oak Appliance Company, of New Orleans, has reduced the scale of their operations to fit the current situation. This one store serves in place of four formerly operated in various parts of the city. Outside sales force has been trimmed from fifteen to four men . . . and these spend most of their time looking for merchandise that can be purchased for resale.

Open Wiring for War Plants

In these hectic days of getting war plants into production, the primary considerations are the saving of time, materials and man-power. Open wiring answers all of these requirements.

By F. C. Van Etten*

YOU CAN'T fly planes, navigate ships, drive tanks, nor shoot guns that are still in the blue print stage. War plants must be placed in production quickly. Because of delay in securing materials and in order to reduce construction time, open wiring is being installed in many new projects. It does not follow, however, that such construction is temporary. In normal times, a number of large industrials have standardized on open wiring. There should be no hesitancy about using open construction during the emergency.

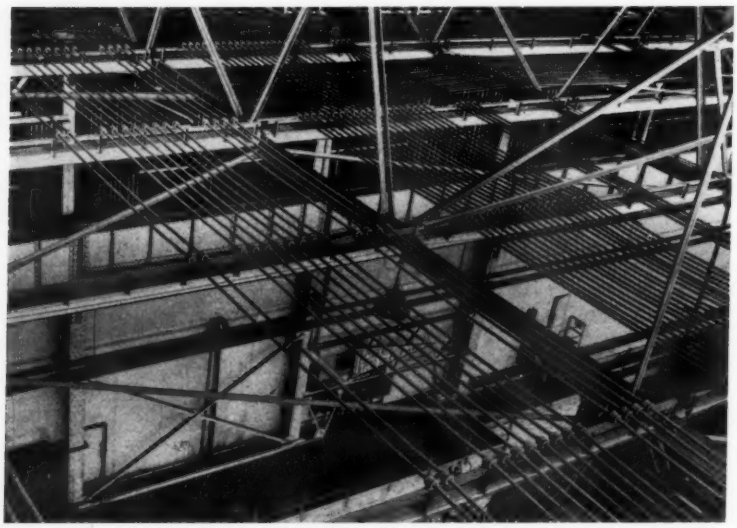
Open wiring has many practical advantages aside from saving of time, material and labor. It is less expensive and offers greater flexibility — extensions, changes, additional taps, and rearrangements can be made easily and quickly. Cables can be worked at higher current densities, consistent with required voltage regulation.

*Mr. Van Etten is associated with the Delta-Star Electric Company, of Chicago, Ill.

Two types of cable supports are in general use, the individually clamped, horizontally spaced type and the three-conductor, triangular spaced support. Both types can be supplied with separate bases for mounting on pipes, beams or flat surfaces, but during the emergency, it is recommended that supports be used without bases wherever possible in order to conserve materials.

Single-Conductor Supports

The single-conductor fitting can be mounted individually, or assembled in groups of two, three, or four on a common base and mounted as a unit. This type has the advantage that spacing between conductors can be varied, but on the other hand, all conductors are in the same plane and as a result the electrical characteristics for a-c circuits are not favorable. Ordinarily these fittings are supplied with one portion of clamp non-ferrous for use with a-c conductors, but present conditions dictate use of all steel clamps for cables up to 1⅛" diameter; heating is not serious. For cables 1⅛" to 1½", steel clamps with high strength bronze bolts are permissable. Above 1½", one portion of clamp must be bronze, but steel bolts and nuts can be used. With d-c conductors, heating is not a factor; clamping members, bolts and nuts can be of ferrous materials.



This is a splendid example of open wiring with single-conductor cable supports. For a-c cables over 1½-inch in diameter, part bronze clamps are required although steel bolts and nuts can be used.

Three-Conductor Supports

In the three-conductor triangular design, all conductors of a circuit are within the same clamp and heating does not occur. The close triangular spacing results in a balanced circuit with impedance drop reduced to a minimum for open construction. Minimum space is required, a factor of considerable importance when several circuits are necessary. Electrical balance due to triangular spacing permits connecting in multiple two or more circuits of same size conductors—four circuits in multiple have been used. On long runs, transposition of cables in one support with respect to cables in another support can be accomplished very readily by simply rotating porcelain insulator sections within clamp. Use of multiple conductor circuits instead of large diameter cables may be a factor of considerable importance from standpoint of delivery during the emergency.

The fixed dimensions of the three-conductor support make it easy to determine electrical characteristics of a circuit. To assist the plant electrician, the accompanying table has been prepared. With this table, the voltage conditions of a 60-cycle, three-phase, three-wire circuit can be obtained with about the same ease as for a d-c two-wire circuit.

The table gives the drop per ampere per 1000 ft. of three-phase, three-wire circuit—at load power factors noted—expressed in per cent of a load voltage of 220. If

load voltage is 110, multiply the percentage factors in table by 2, but if 440, then divide by 2.

This table takes into consideration the skin effect of conductors at 60 cycles but does not compensate for proximity effect which is considered unimportant.

Wire Sizes Easily Calculated

The load voltages are assumed fixed at approximately standard motor voltages, i.e., 110, 220 and 440. It is then necessary to assume an allowable drop expressed in per cent of load voltage. The plant electrician generally has a definite idea of what he considers an allowable voltage drop. While the Code permits 3% for power circuits, there appears to be no reason why this could not be exceeded under emergency conditions when necessary, provided generator voltage is sufficiently high to provide full motor voltage or better.

Three-conductor supports offer many advantages: minimum space, balanced voltages, low impedance drop. The supports shown here are made up of porcelain sections within a steel clamp. Note taps to circuits.

Power factor of the load must be known or assumed. In using the table be sure to use per cent voltage drop listed for assumed or known load power factor.

Calculate the current per wire from the formula:

$$P = 1.73 \times E \times I \times PF$$

where "P" is the three-phase load in watts, "E" is the load voltage, "I" is the current per wire in amperes, and PF is the per cent power factor of the load.

Select a trial wire size. From table, find the unit percentage drop, then multiply this factor by number of amperes per wire (I) and distance (L) expressed in units of 1000 ft. (if distance is 600 ft., then L is 0.6). The value so obtained is the total drop of the circuit expressed in percentage of load voltage (E). If this percentage is too high or too low, select a larger or smaller cable as required, and make another calculation. After a little experience, proper size can be quickly determined.

Typical Example

Problem: what size wire is necessary to carry 35 kw over a 3-phase, 3-wire circuit for a distance

(*Continued on page 56*)

Table of Per Cent Voltage Drops for Triangular Spacing of Conductors

Conductor Size A.W.G. or MCM	*Ampere Capacity	60 Cycle A C Resistance and Reactance at 50° C. for 97.3% Conductivity Copper		Voltage Drop per Amp. per 1000 Ft. of Circuit In Percent of 220 Volts at the Load				
		Resistance Ohms per 1000 Ft. of Stranded Conductor	Reactance Ohms per 1000 Ft. of Stranded Conductor	at Power Factors of				
				60%	70%	80%	90%	100%
3" Conductor Centers								
6	65	.4612	.0873	.2806	.3086	.3354	.3570	.3643
4	87	.2898	.0822	.1920	.2079	.2225	.2327	.2288
2	118	.1826	.0769	.1360	.1444	.1516	.1549	.1445
3-11/16" Conductor Centers								
1	136	.1449	.0801	.1195	.1250	.1291	.1294	.1150
1/0	160	.1150	.0774	.1035	.1069	.1090	.1075	.0917
2/0	185	.0911	.0749	.0904	.0922	.0927	.0899	.0729
3/0	215	.0723	.0721	.0796	.0803	.0797	.0758	.0583
4/0	248	.0574	.0681	.0700	.0698	.0684	.0641	.0467
250	280	.0487	.0662	.0647	.0640	.0621	.0574	.0399
300	310	.0407	.0641	.0596	.0585	.0562	.0512	.0337
350	350	.0350	.0623	.0558	.0544	.0518	.0466	.0293
400	380	.0307	.0608	.0529	.0512	.0485	.0432	.0259
500	430	.0246	.0579	.0482	.0464	.0434	.0381	.0214
4-3/32" Conductor Centers								
600	480	.0206	.0570	.0459	.0438	.0406	.0352	.0184
700	525	.0179	.0550	.0434	.0412	.0381	.0327	.0164
750	545	.0168	.0543	.0424	.0403	.0371	.0317	.0155
800	565	.0159	.0535	.0415	.0393	.0361	.0308	.0148
900	605	.0142	.0522	.0399	.0377	.0346	.0293	.0137
1000	650	.0130	.0510	.0386	.0364	.0333	.0281	.0129
4-9/16" Conductor Centers								
1250	740	.0086	.0509	.0367	.0342	.0308	.0253	.0097
1500	815	.0069	.0488	.0347	.0322	.0288	.0235	.0085
1750	890	.0057	.0469	.0330	.0306	.0273	.0222	.0076
2000	960	.0047	.0454	.0316	.0292	.0260	.0210	.0069

*Rubber Covered, Single-Conductor in Free Air, Room Temperature 30° C.

Industrial Wiring Practice

Part 7—A discussion of some of the special factors involved in the design and installation of bare conductor feeders for heavy currents. (Code Article 328)

By B. Z. Segall

ARTICLE 328 of the Code permits the installation of bare conductor feeders. The local inspection authority, however, must give special written permission for such installations and may require, in addition to the provisions set forth in this Code article, other safeguards to insure safety to life and property.

The general conditions for the use of bare conductors state that the installation must be made in (a) buildings of fire resistive construction, only, (steel, re-enforced concrete, etc.) and, (b) shafts, chases or channels constructed of non-combustible material (concrete troughs, steel wireways, etc.)

In other words, these installations are similar to busway systems in that they are bare copper (or aluminum) conductors properly supported and insulated and protected from mechanical injury by isolation or by non-combustible material. Busways are made up almost entirely at a factory and require but a small amount of labor for assembling of the prefabricated parts and mounting them in position in the plant or building; bare conductor installations are more or less prepared as required at the installation and usually must be completely fabricated "on location."

It should be noted that Article 328 is entitled "Bare-Conductor Feeders." The text of the article further emphasizes this limitation by stating that this type of construction "may be used for feeders only." Furthermore there is a limitation of voltage, i.e., the bare conductors can only be installed if the potential between conductors is 600 volts or less.

In certain locations the use of bare conductors as feeders is entirely precluded, for example, in (a) damp or wet locations, (b) hazardous locations, or (c) locations subjecting the conductor to corrosive vapors. (Under certain conditions, however, bare conductors are used as feeders in battery rooms.)

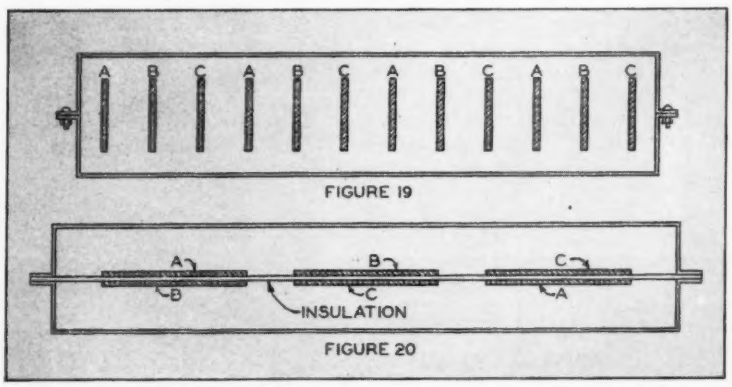
There is one rule in the code for bare conductor feeders that should be applied with extreme caution. This permits a maximum current density of 1,000 amperes per square inch of cross sectional area of copper conductors located in unventilated enclosures. If the enclosure is ventilated this density may be stepped up to 1,200 amperes per square inch. Thus a ¼" x 4" copper bus has 1 square inch of cross sectional area and may carry from 1000 to 1200 amperes depending upon ventilation facilities. Two such bars per phase would carry 2000 and 2400 amperes per phase, respectively, and so on.

In general, d-c feeders may be adequately designed upon this basis if proper provisions are made for ventilating and supporting the busses. A-c feeder bus capacities, however, cannot be based on this simple relationship of current to square inch area. As pointed out in an earlier discussion, the a-c magnetic field set up by the alternating current in the busses produces two effects which upset the current distribution within the conductors.

"Skin effect" causes a greater current density in the outer portion of the bus. This is due to the reactance set up within the bus itself by the a-c magnetic field cutting the bus as it sweeps back and forth through its 60 cycle variations. The reactance is a maximum at the center of the conductor and decreases as it approaches the outer perimeter of the bus.

The "proximity effect" is also a result of the a-c magnetic field. In addition to concentrating the current density in the outer layer of the conductor, this magnetic field tends to separate the conductors of opposite phases. This further tends to shift the internal conductor reactance and upsets the current distribution within the bus so that the greatest current flows in the outer sections of the busses nearest each other.

This force, tending to move the conductors apart, can be of appreciable value for short circuit conditions in high voltage circuits. At the instant of short circuit, the mechanical strain on the bus support is directly proportional to the distance between the busses. Furthermore it varies as the square of the normal station kva



Figs. 19 and 20. Several methods have been devised to improve the heat transfer characteristics of flat busses and to increase the current carrying capacity of such bus systems. Typical examples are the interlacing of busses of different phases and the use of close spacing of opposite phases.

capacity, the square of the bus voltage and the square of the impedance of the circuit from the generators to the point of short circuit on the busses.

Most calculations of this effect are done with empirical formulae and curves. A 150,000-kva, 6600-volt station having 8% reactance will have about 6000 pounds acting at the bus support for busses on 15-inch centers and supported every four feet. This is a considerable force and must be adequately counterbalanced by well designed bus supports to limit the effects of short circuits on the bus system. While the example above is based on a relatively high voltage system the effect on low voltage systems must also be recognized. Well designed and strong bus supports should always be provided.

Busses for Large Currents

When two or more flat busses are used per phase, the two effects described above operate to further limit the capacity of the bus system so that for 3000 amperes and above, elaborate and intricate arrangements must be made of the flat busses to limit the heating and to assure maximum current capacity of the conductors. Examples are the interlacing of busses (see figure 19), the use of close spacing of opposite phases, (see figure 20), and methods devised to improve the heat transfer characteristics and to increase the current carrying capacity of the flat bus systems.

Another method used to build up the carrying capacity and at the same time keep the heating low is to use other than flat configurations of bus section. For example, copper tubes will offer the lowest impedance, inherently, to a-c. It will not, however, approach the low reactance values available from arrangements such as that shown in figure 20 since the minimum center line spacing of the tubing will usually be greater than that of the special low reactance assembly. Such copper tubes, however, may be oil or water cooled to further increase the current capacity.

Channel busses are another means of obtaining higher current carrying capacities with a minimum heating of the conductors. Usually two channels are arranged in a square and this results in a relatively high capacity system which has great rigidity as well as large heat dissipating areas.

Two angular busses may be formed into a square in much the same manner as the channels. The rigidity will not be quite as great but excellent characteristics may be obtained from such a system.

Some very interesting tests have been made on the various bus systems. For example, one manufacturer shows the result of a current and heating test on a ten-bar conductor of 3" x ⅛" flat busses. For a total load of 4300 amperes on the bus, the test showed that each bar carried the following current:

Bar No.	Amperes
10 (closest to return)	1000
9	720
8	510
7	350
6	240
5	225
4	250
3	340
2	480
1 (fartherest from return)	670
Arithmetical sum	4785

The arithmetical sum of the individual bar currents are greater than the actual total current of the entire conductor. This is due to the fact that the individual bar currents are not in phase with the actual total bus amperage. In some of these bars the currents are leading and in others they are lagging the bus current. If the above bar currents are added vectorially the total thus obtained will equal the 4300 ampere value for the entire bus.

The heating test showed the following temperature rise in each individual bus for the individual currents set up in each bus as shown in the above table:

Bar No.	Deg. C. Rise
10	68
9	43
8	24
7	13
6	8
5	6
4	7
3	10
2	15
1	24

It should be noted that the bars closest to the return conductor not only showed the effects of the heat transfer from the adjacent busses of its own phase but most likely were affected by the heat from the return conductor busses of the other phase.

A d-c feeder system consisting of the above bus arrangement and based on a 1200 ampere density

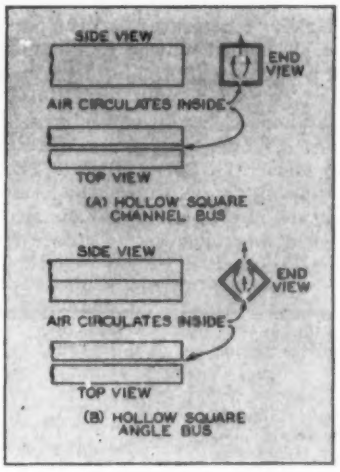


Fig. 21. Bus systems utilizing copper channels or copper angles usually result in better installations than where hollow tubing is used. Ventilation may be obtained on the inside surfaces as well as the outside, and this will permit a higher rating of the bus.

would carry approximately 4500 amperes. The heating in all probability would be somewhat less and more uniformly distributed. A 30° C. (86° F.) rise above normal ambient (usually 40° C. or 104° F.) is the basis used for the design of bus systems. On this basis, it is interesting to note that a single ¼" x 3" bus will carry 1000 amperes and a single ¼" x 4" has a 1300 ampere capacity. Increasing the number of busses per phase with a ¼" spacing between the busses set with faces vertical does not increase the capacity in direct proportion to the number of busses and current density per single bus. Thus:

No. of Busses	Ampere Capacity for 30 C. Rise
2—¼" x 3"	1650
3—¼" x 3"	1850
4—¼" x 3"	2250

The current densities for the ¼" x 3" busses show some very interesting values:

No. of Busses	Current Density Amps. per sq. in.
1—¼" x 3"	1333
2—¼" x 3"	1100
3—¼" x 3"	825
4—¼" x 3"	750

The following tabulation shows the corresponding values for ¼" x 4" bus:

No. of Busses	Ampere Capacity	Current Density
1—¼" x 4"	1350	1350
2—¼" x 4"	2250	1125
3—¼" x 4"	2500	833
4—¼" x 4"	3000	750

Higher temperatures are permissible, and it will be found that factory fabricated bus systems operating continuously at full load under normal conditions of ventilation will show a considerable rise above the 30° C limit. The tabulation below shows the temperature rise at a current density of 1000 amp. per sq. in. for different capacities:

Type	Ampere Capacity			
	1500	2000	3000	4000
Standard Bus	100° C.	130° C.	210° C.	
Interlaced	88° C.	96° C.	102° C.	103° C.
Low Reactance	58° C.	62° C.	67° C.	78° C.

In an effort to reduce the heating of the interlaced and standard ducts manufacturers paint both the casing and the bus with a special type of paint which increases the surface thermal emissivity of both the casing and the bus and augments the heat transfer from the bus to the surrounding air outside of the casing. The advantage gained is indicated, for example, in the case of a standard 3-phase 1500-ampere duct with an aluminum casing: casing and bus unpainted, temperature rise = 100° C.; casing and bus painted, temperature rise = 66° C.

A similar test on an interlaced duct showed the following results: casing and bus unpainted, temperature rise = 88° C.; casing and bus painted, temperature rise = 54° C.

In the design of laminated flat bus conductors it is important, therefore, to consider the location of busses with respect to each other and to the return conductor. The heat dissipating surface area is also an important factor in bus design. The voltage drop and temperature rise are of considerable magnitude and must be carefully calculated for job fabricated installations. While much manufacturer's data is available for designing flat bus systems, it is best to first consider a factory fabricated duct or the use of tubular or hollow form busses.

Tubular busses give a highly efficient current carrying conductor. The wall thicknesses should be kept to about ½" for maximum capacity and minimum voltage drop. A 6" trade size tube of 98% conductivity copper will permit a density of about 830 amperes per square inch if operated indoors and approximately 950 amperes per square inch if installed outdoors. These values are based on obtaining a 30° C. rise. This temperature increase will result from a loading of 4150 and 4750 amperes indoors and outdoors, respectively. Smaller tubes have a somewhat higher allowable density, thus a 2" trade size shows 1200 amperes and 1450 amperes, indoor and outdoor, respectively, for a 30° C. rise. If a higher temperature rise is permissible, then the capacity may be increased by the following formula:

$$C_t = \sqrt{t/30} \times C_{30}$$

Where C_t is ampere capacity for temperature rise t, and C_{30} is ampere capacity based on rise of 30° Cent.

The voltage drop, however, may prohibit the use of a higher current density for comparatively long runs of bus section.

The square hollow bus structure, formed by using high conductivity copper channels or copper angles, is usually a much better installation than the tubular job. Ventilation may be obtained on the inside surfaces as well as the outside as a result of the openings at the channel or angle edges for the entire length of the square formed by the structual units. (See figure 21.) This permits a higher rating of the bus. As an example, a 4" channel bus has a total area of 4.44 square inches and a capacity for a 30° C. rise of 4000 amperes. This results in a density of 900 amperes per square inch as compared to a density of 830 amperes for the 6" tube having an area of 5 square inches and a capacity of 4150 amperes.

Hollow busses may also be obtained for much higher capacities than the tube busses. A 6" tube is the maximum standard size usually made, whereas the bus channel may be obtained in a 9" size having a total capacity of 10,000 amperes for a 30°C. rise above a 40° C. ambient. The density at this high capacity is about 625 amperes per square inch.

The maximum standard bus is a 6" x 6" size and it is rated, on the same basis as the other types of busses (30° C. rise above 40° C.), at 8,000 amperes. The density is approximately 1,400 amperes per square inch and is so much greater than the channel type due to the inherent streamlining obtained with the structure. All surfaces, arranged as shown in Figure 21, with the other phases installed in the same horizontal plane, tend to radiate heat at a maximum rate.

The inductance of these flat and hollow bus structures has been the subject of much study. H. B. Dwight, in the *Electric Journal*, volume 16, dated 1919, and the Electric Review, volume 70, dated 1917, has set up curves for the reactance values for rectangular (solid) conductors and strap (flat) conductors, respectively. More recently Dwight and Wang published formulas for obtaining the reactance of square tubular busbars having thin walls. These are to be found in the AIEE Transactions, volume 57, dated 1938. Within the past two years, T. J. Higgins has published two papers. One deals with hollow rectangular conductors and was published in the *Journal of the Franklin Institute*, volume 230, dated 1940. His latest paper AIEE No. 41-168 published October, 1941, develops some highly technical formulas for the rectangular tubular conductors. Several foreign papers are also available.

As a summary, the following facts should be kept in mind. First, use available factory fabricated units wherever possible. This will be found in most cases to be most economical, to have rather complete data as to reactance and heating and in general to lend itself to quick analysis and application to any particular installation. Particular attention should be paid to the reactance if runs over 50 feet are involved, and low reactance units should be used wherever long feeder runs are involved.

Job fabricated bus systems require considerable engineering and should be undertaken only with a full knowledge of all the factors involved.

Specialization in War-Work Is This Contractor's Answer

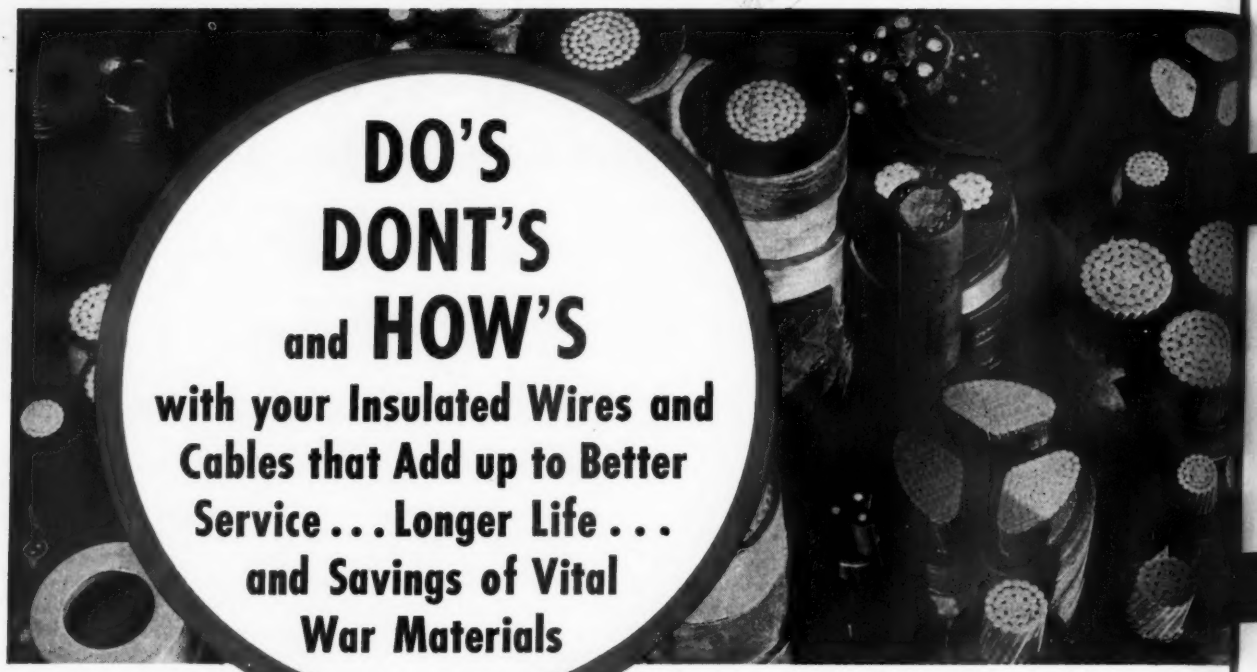
AN EXCELLENT example of how outwardly small changes in operating policies can fortify the large-scale electrical contractor against loss of revenue from his former service is provided by Shelby Electric Company, Memphis, Tennessee, now handling a number of important war production installations south of the city.

Meeting war conditions as Jack Hunt, vice-president of Shelby Electric sees it, means choosing a specific field, and sticking to it to the point of specializing. "Specializing" is nothing new to this mid-south firm, for during the last several years, Mr. Hunt has specialized in two phases of electrical work which built the firm to one of the largest in the city. These were motor repairs, including rewinding, rebuilding, armature work, rentals, and other services for large power users, and industrial wiring contracts for the many factories and shops which have sprung up in or near Memphis since 1935. These two services, in combination with standard installation of commercial wiring, housewiring, and repair and remodelling work, constituted Shelby Electric Company's entire business until shortly before the war.

Now, there have been substantial changes. Like many other contractors, Mr. Hunt thoroughly investigated the possibilities of repair work before making up his mind which way to turn. Because of materials shortages, he believes, there will be very little profitable remodelling, or large scale repair jobs available. "Our motor service is a perfect example of that point," he pointed out, "At one time, we were supplying motors on almost any basis, rebuilt, rewound, or simply rented, to any user in Arkansas, Tennessee, Mississippi, etc., who needed it. We built up this end of the business from a relatively small phase to more than 25% of our total sales up until 1941. We are still getting calls for motors, naturally amplified since they have been frozen by the government, and a heavy amount of repair-service requests which we can't answer. But our motor business is stymied altogether by copper shortages. However, it is almost certain that the demand for motors will make necessary some type of government action, and that some of the essential copper will be released. Right now, it takes an A-1-J priority rating or better to obtain motor copper of any kind. If we had a plentiful supply, we

(*Continued on page 54*)

One of the Shelby Electric Company's recent jobs — a pumping station which will include six 2000-hp, 15,000-volt motors. Note the specially constructed templet for holding conduits in place while concrete slabs are being poured.



DO'S DONT'S and HOW'S

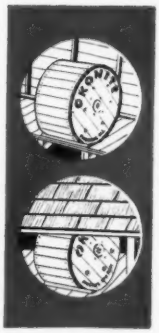
with your Insulated Wires and Cables that Add up to Better Service . . . Longer Life . . . and Savings of Vital War Materials

How to Preserve Wires and Cables in Storage

When you have to keep insulated wires and cables on hand for any length of time, follow these simple rules for keeping deterioration to an absolute minimum.

STORE IN A COOL PLACE

High temperatures tend to break down rubber—shorten its life. Stored in a cool (not cold) uniform temperature, cable insulation is kept in the best condition for the longest possible life when finally installed on the job. Always avoid extreme temperatures.



KEEP REELS AND COILS OFF GROUND

Continued moisture rots wooden reel heads and fibrous cable coverings. Sound reels are easier to handle and well-preserved cable coverings give longer life in service.

PROTECT CABLES FROM WEATHER

Sunshine, light, rain, snow and freezing can hasten deterioration of rubber sheaths and fibrous coverings. Keep cables under cover as much as possible. If this is impractical, be sure to keep lagging on reels.

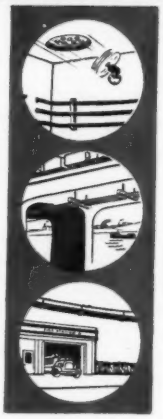
Add Extra Life to Insulation on Outdoor Wires and Cables

REMEMBER THIS BASIC IDEA—

You can operate cables more efficiently by reducing the temperature of the surrounding air (ambient temperature) because:

1. insulation will last longer with the same conductor load, or
2. more current can be carried in the same cable without shortening its life.

KEEP RISER CABLES ON THE NORTH or most shaded side of the poles—away from the heat of the sun.



IN HOT MANHOLES, INSTALL VENTILATING FANS and perforate manhole covers to drive hot air out.

ON BRIDGES, VIADUCTS, ETC., PLACE CABLES BELOW THE STRUCTURE for protection from sun and weather. This also is more likely to safeguard cables from accidental mechanical damage, vandalism and sabotage.

FOR AERIAL CABLES STRUNG ON MESSENGER—preserve sheaths and fibrous coverings with weatherproof paint to stop corrosion and flaking of saturants.

Get More Service Out of Your Heavily Loaded Cables

UNDERGROUND INSTALLATIONS (without ducts)—keep ground saturated with water to lower earth temperature and dissipate heat more readily.

TUNNEL INSTALLATIONS—ventilate tunnels with grills where possible or install a blower at one end of the tunnel to force hot air out. Make sure circulation goes all the way through tunnel so hot air does not pile up at one end.

DUCT INSTALLATIONS — when possible circulate cool water through or flood duct lines and keep manholes flooded. But be sure your cables are water-tight.

Prolong Life of Your Wiring Circuits in Hot Locations—Indoors

WHEN WIRES ARE INSTALLED NEAR HEATING UNITS or hot pipes, move the wiring or insert baffles between steam pipes and cables to deflect hot air from the cables.

WHEN WIRES ARE INSTALLED IN HOT ROOMS—provide circulation by the use of fans to blow hot air away. Such precautions are less necessary if you are already using Okolite heat-resisting rubber Okoglass or Okobestos cables which are designed for long-life under these conditions.

WHERE ONLY MILDLY HIGH TEMPERATURES EXIST — cut air vents in the ceiling or partition providing adequate circulation by means of natural convection.

To Make Rubber-Covered Portable Cords and Cables Last Longer

PROTECT cords from being run over by heavy moving equipment, dragged around sharp corners, yanked to remove kinks. While Okocord rubber-sheathed cords and cables are built to stand up under tough service, unnecessary abuse shortens their life.

KEEP your cords and cables — as much as is practically possible — away from high voltage equipment and sparking motors. Such machines generate ozone which attacks rubber and hastens its deterioration.

DON'T run cords and cables over small diameter pulleys or drums. Continued bending and flexing around a short radius breaks the conductors. Use larger diameter pulleys and get longer service from your cords.

WIPE them regularly so they are free from oil, grease and chemicals. Such agents attack rubber and shorten its life.

KEEP them out of light and sunshine as much as possible when in use. Light tends to harden rubber—thus hastening cracks.

KEEP them away from steam lines, furnaces and hot objects as much as possible. High temperatures shorten the life of rubber.

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OKONITE

INSULATED WIRES AND CABLES

Single-Phase Winding Design For Old Motor Frames

By A. C. Roe*

THE REWINDING of a single-phase motor, exactly as it was wound at the factory, is usually easy enough when all the data on the original winding are available. It is not so easy, however, to make changes in the distribution of the running and starting windings of a single-phase motor and be sure of the results without considerable experience in this work or a full understanding of the design principles involved. In this article, practical details are given on the changes that it is possible to make in such windings. In addition, complete data are shown for the windings used on a number of single-phase motors, which will be found useful when laying out a new winding or changing an old one.

While it is not always advisable to change the design of small motors without first securing full data on the original winding from the motor manufacturer, there are certain fundamentals of design that can be effectively employed to determine the limitations of possible changes. An understanding of these fundamentals will help to prevent mistakes and aid in laying out a new winding when cores have been stripped before being received, or in correcting the mistakes of others who have changed the original winding in such a way that operation is unsatisfactory.

The conditions that will be discussed are as follows: (1) method of laying out new running and starting windings for a small single-phase motor when it is desired to rewind an old core and the original winding data are not known; and (2) method of laying out a new starting winding for a small motor in which the main or running winding is intact, but the starting winding data have been lost or a mistake was made in a previous rewinding job, resulting in such unsatisfactory operation that rewinding is made necessary.

The first point to consider in any case when a single-phase winding is changed is the determination of the horsepower for which the motor frame may be used, which assumes that this information is not available from the nameplate or that the nameplate has been removed. To assist in determining the rating of the frame and securing the other data, Table I has been worked up for ready reference.

In Table II, data are given for ten typical single-phase motor windings. From this information, the turns per slot and per pole and the size of wire for ratings from 1/30 hp up to 1/2 hp can be obtained, together with much other data that will be found helpful in many instances.

When using this tabulated information, the first thing to do is to find the rating possible for the core under consideration. To do this, measure the bore and length of the core and then refer to the data for the typical windings given and match up your data with those given in one of the examples, so as to insure a conservative rating for the core that must be rewound.

The next step is to find the total number of turns per pole. Here again the tabulated information for the ten typical motor windings will help to simplify calculations and save considerable time, as well as avoid possible mistakes in long calculations. The examples provided give good standard methods for distributing the turns over the pole face area, that have been found to be good practice and result in good motor operation. Therefore, instead of tabulating the flux per tooth in relation to a sine curve, the ampere turns and the factor for determining the conductors per slot, we can find the total flux per pole phase and then the turns per pole from the tabulated information presented. The motor repair man should build up a file of such data from standard motors.

To determine the total flux per pole, it will be necessary to assume values for the air gap density in lines of force per square inch. The following values will be found satisfactory:

Up to 1/8 hp, 20,000 lines per square inch.

For 1/4 hp, 25,000 lines per square inch.

For 1/2 hp, 30,000 lines per square inch.

For 1 hp, 35,000 lines per square inch.

Then find the area of each pole in square inches and multiply this by the above value of lines per square inch corresponding to the required horsepower of the frame. The area of the pole in square

*Mr. Roe is motor engineer for Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Table 1—Minimum Cylindrical Inches* for Maximum Single-Phase Motor Rating

(Data applicable to four-pole, 1800 rpm, 60 cycle motors.)

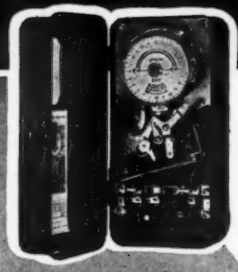
Cylindrical Inches*	Rating in Hp.
18.0	¼
30.0	⅜
37.5	½
45.0	¾
60.0	1

*The term "cylindrical inches" is used in motor design to designate the product B x B x L, where B is bore diameter in inches and L is the length of iron in core in inches. The cylindrical inches, as calculated in this manner, is a convenient guide to the horsepower rating of a motor frame. The values given in the table are for four-pole motors. Multiply these values by 1.5 to obtain cylindrical inches of six-pole motors and by 1.85 to obtain cylindrical inches for eight-pole motors.

MULTIPLY

THE ADVANTAGES OF PROTECTIVE FLOODLIGHTING WITH . . .

AUTOMATIC CONTROL



DURING BLACK-OUTS

If a master-switch is pulled during temporary black-outs, Form VSWZ will continue to run for 10 hours. During any current interruption, an automatic carry-over feature provides for clock-spring operation of the complete time-switch mechanism. When the current is restored, the clock-spring rewinds automatically and the time-switch resumes its normal operation.

SANGAMO TIME-SWITCHES

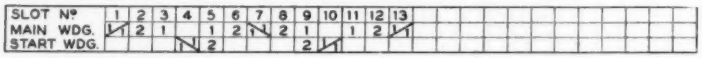
THE advantages of protective floodlighting systems for factory yards, building approaches, railroad sidings, storage yards, and other vital property serving in war production, are multiplied when full automatic control is used. A Sangamo Astronomic Dial Time-Switch with synchronous carry-over provides this kind of control. It changes its operating sequence daily, so that the "on" and "off" operations of the lights conform with sunset and sunrise. Its sequence of operations remains undisturbed by power interruptions up to ten hours. It requires no manual operation nor re-setting the year 'round. Select this, or any other form best suited for your specific needs from the complete line of Sangamo Time-Switches.

SANGAMO ELECTRIC COMPANY SPRINGFIELD ILLINOIS

Table II—Design Data on Typical Motors

Typical Winding No. 1

1/30 hp; 110 volts; 1.25 amps; 60 cycles; 1700 rpm; 4-poles; and 24 slots. Bore = 2.75 inches; core = 1.25 inches in length.

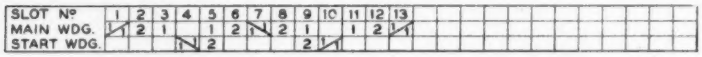


Main Winding
50 turns of No. 25 (.0179) paper and enamel insulated wire
Skein factor = 8
Turns per pole = 400
Series connection.

Starting Winding
14 turns of No. 30 (.010) enamel insulated wire
Skein factor = 12
Turns per pole = 168
Starting turns = 42% of main winding turns.

Typical Winding No. 2

1/12 hp; 110 volts; 60 cycles; 1725 rpm; 4-poles and 24 slots. Bore = 2.75 inches; core = 1.37 inches in length.

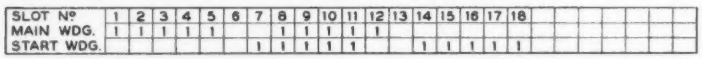


Main Winding
40 turns of No. 23 (.0226) paper and enamel insulated wire
Skein factor = 8
Turns per pole = 320
Series connection.

Starting Winding
25 turns of No. 27 (.0142) enamel insulated wire
Skein factor = 6
Turns per pole = 150
Starting turns = 47% of main winding turns.

Typical Winding No. 3

1/6 hp; 110 volts; 3.6 amps; 60 cycles; 3400 rpm; 2-poles; and 24 slots. Bore = 3 inches; core = 1.5 inches in length.

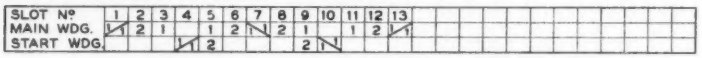


Main Winding
36 turns of No. 16 (.051) paper and enamel insulated wire
Skein factor = 10
Turns per pole = 360
Series connection.

Starting Winding
30 turns of No. 27 (.0142) enamel insulated wire
Skein factor = 10
Turns per pole = 300
Starting turns = 83% of main winding turns.

Typical Winding No. 4

1/6 hp; 110/220 volts; 60 cycles; 1725 rpm; 4-poles; and 24 slots. Bore = 3.12 inches; core = 1.63 inches in length.

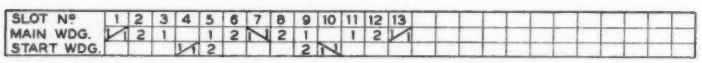


Main Winding
46 turns of No. 22 (.0254) paper and enamel insulated wire
Skein factor = 8
Turns per pole = 368
Series connection for 220 volts; parallel, for 110 volts.

Starting Winding
34 turns of No. 28 (.0126) enamel insulated wire
Skein factor = 6
Turns per pole = 204
Starting turns = 56% of main winding turns.

Typical Winding No. 5

1/8 hp; 110/220 volts; 2.5/1.25 amps; 60 cycles; 1725 rpm; 4-poles; and 24 slots. Bore = 3.13 inches; core = 1.25 inches in length.



Main Winding
70 turns of No. 23 (.0226) paper and enamel insulated wire
Skein factor = 8
Turns per pole = 560
Series connection for 220 volts; parallel, for 110 volts.

Starting Winding
58 turns of No. 30 (.010) enamel insulated wire
Skein factor = 8
Turns per pole = 464
Starting turns = 82% of main winding turns.

(This table is continued on page 42)

inches may be found from the formula:

A = (3.1416 x B x L) / P

where A is the area in square inches, B the bore of the stator in inches, L the length of the core in inches, and P the number of poles.

The total number of lines of force, or flux, per pole phase equals the lines per square inch times the total square inches per pole.

The turns per pole may be found by multiplying the voltage at which the motor will operate by 370,000 and dividing this product by the total flux per pole. This applies to 60-cycle motors only, the only type discussed in this article.

From the above calculations, the total number of turns per pole is obtained and the next step is to arrange these turns into the proper number of turns per slot or per skein. To simplify this, it can be assumed, in all cases, that both the starting and the running windings will be skein wound, or the main winding may be hand wound but use data as if skein wound.

Next, turn to the typical examples of motor windings, in Table II, where the number of times that the skein is passed through each slot is given. In these examples the number I indicates that the skein is passed through the slot only once, the number 2 indicates that the skein is passed through a slot twice, and so on. If hand wound, the turns per slot will be one or two times the turns shown per skein.

For example, refer to winding No. 10. In the main winding the skein passes through slot 7 once, through slots 8, 9, 10, 11 and 12, twice, and through slot 13 once, or a total of 12 times per pole. In this case, the total turns per pole equals the turns per skein times the skein factor per pole. This is, 32 x 12 = 384 turns per pole.

On the other hand, if we know the total turns per pole and want to find the turns per skein, simply divide the turns per pole by the skein factor given for the windings considered in examples Nos. 1 and 10. Take for example winding No. 4. The main winding has 368 turns per pole and the skein factor is 8. Then the turns per skein equal 368 ÷ 8 = 46 turns. To convert turns per skein into turns per slot, multiply the turns per skein by the figure in each

Hotpoint Announces
a *Wartime Service Program*
for All Hotpoint Appliances

HOTPOINT'S new Wartime Service Program is designed to accomplish two things: 1. To insure your customers that appliances will be kept in operation for the duration, 2. To cooperate with the nation's war effort by conserving critical materials.

During its nearly forty years of history, Hotpoint has been outstanding in the industry for prompt, efficient and complete service. During World War I the millions of Hotpoint appliances then in service were kept operating. And we will continue that policy during the present emergency.

Adequate stocks of functional parts, such as range units, switches, etc., will be maintained by Hotpoint distributors in approximately 75 warehouses from Coast to Coast. A staff of field service engineers is being maintained in every sales district to train and assist distributors and retailers in their service problems. Parts and installation service will be readily available when required, in every community.

To assist the government in the conservation of critical materials, Hotpoint's program provides for the return of all parts containing such materials, to be remanufactured or salvaged for the government stock pile.

Ask your Hotpoint distributor for further information about this Wartime Service Program. Edison General Electric Appliance Co., Inc., 5614 W. Taylor St., Chicago.

Hotpoint ELECTRIC APPLIANCES

Table II—Continued

Typical Winding No. 6

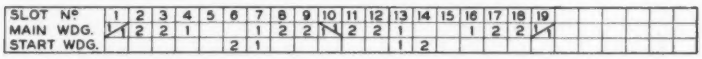
1/4 hp; 110 volts; 60 cycles; 1725 rpm; 4-poles; and 24 slots. Bore = 3.25 inches; core = 1.87 inches in length.

Main Winding
64 turns of No. 18 (.040) paper and enamel insulated wire
Skein factor = 10
Turns per pole = 640
Connect 2-parallel for 110 volts.

Starting Winding
59 turns of No. 30 (.010) enamel insulated wire
Skein factor = 10
Turns per pole = 590
Starting turns = 90% of main winding turns.

Typical Winding No. 7

1/4 hp; 110 volts; 4.18 amps; 60 cycles; 1725 rpm; 4-poles; and 36 slots. Bore = 3.63 inches; core = 1.5 inches in length.

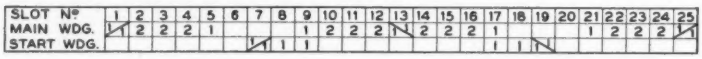


Main Winding
37 turns of No. 21 (.0285) paper and enamel insulated wire
Skein factor = 12
Turns per pole = 444
Connect 2-parallel for 110 volts.

Starting Winding
45 turns of No. 26 (.0159) enamel insulated wire
Skein factor = 6
Turns per pole = 270
Starting turns = 60% of main winding turns.

Typical Winding No. 8

1/4 hp; 110 volts; 60 cycles; 1750 rpm; 4-poles; and 48 slots. Bore = 4 inches; core = 2 inches in length.

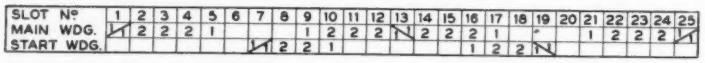


Main Winding
19 turns of No. 19 (.0359) paper and enamel insulated wire
Skein factor = 16
Turns per pole = 304
Connect 2-parallel for 110 volts.

Starting Winding
30 turns of No. 26 (.0159) enamel insulated wire
Skein factor = 6
Turns per pole = 180
Starting turns = 60% of main winding turns.

Typical Winding No. 9

1/2 hp; 110/220 volts; 60 cycles; 1750 rpm; 4-poles; and 48 slots. Bore = 6.37 inches; core = 2.5 inches in length.

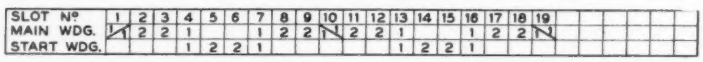


Main Winding
9 turns of No. 14 paper and enamel insulated wire
Skein factor = 16
Turns per pole = 144
Series connection for 220 volts; parallel, 110 volts.

Starting Winding
6 turns of No. 23 enamel insulated wire
Skein factor = 12
Turns per pole = 72
Starting turns = 50% of main winding turns.

Typical Winding No. 10

1/3 hp; 110 volts; 5.35 amps; 60 cycles; 1725 rpm; 4-poles; and 36 slots. Bore = 3.87 inches; core = 2.13 inches in length.



Main Winding
32 turns of No. 20 (.032) single-cotton and enamel insulated wire
Skein factor = 12
Turns per pole = 384
Connect 2-parallel for 110 volts.

Starting Winding
43 turns of No. 26 (.0159) single-cotton and enamel insulated wire
Skein factor = 6
Turns per pole = 258
Starting turns = 67% of main winding turns.

running winding slot. Referring again to winding No. 4, slot 6 would have 2 times 46 or 92 turns, and in slot 7, where two coils overlap, the turns per slot for each coil would, of course, be 1 times 46, or 46 turns.

The next step after determining the proper number of turns, is to find the size of wire to use for the running and the main windings. In general, the wire should be as large as can be wound into the slots. In estimating the sizes required, the following sizes can be used, taken from the current values given in the typical windings, Nos. 1, 3, 5 and 7 of Table II:

Up to 1/8 hp, use 250 to 375 cir mils per ampere

For 1/4 hp, use 400 cir mils per ampere

For 1/2 hp, use 425 cir mils per ampere

For 1 hp, use 450 cir mils per ampere.

After finding the size of wire from the above data, and after the turns per slot and size of wire for the starting winding have been determined, it is a good plan to try the total number of running and starting wires in the slot, and if possible increase the running winding wire one size. In case the starting winding wires make the slot full and tight, the starting winding wire size can be reduced one size without bad effects so as to give a liberal size for the running winding. This completes the necessary data for calculating the running winding.

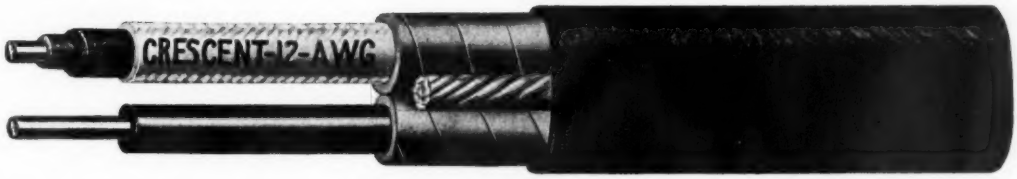
The starting windings of split-phase motors are designed to give phase displacement. This is accomplished by making the resistance of the starting winding high as compared to the resistance of the running winding. The resistance of the starting winding is proportioned so as to limit the starting current to 4 to 6 times the current that is taken at full load.

However, to work out the starting winding by the resistance method calls for calculations that are likely to cause mistakes. It is safer to use known values taken from good existing windings, such as in the windings given in Table II, and then calculate the starting winding data by percentages based on the turns per pole of the running winding. There is less likelihood of making annoying mistakes, if this method is followed.

(Continued on page 52)

VARNISHED CAMBRIC • RUBBER POWER CABLES • BUILDING WIRE • RADIO WIRES • SIGNAL CABLE • FLEXIBLE CORDS • LEAD ENCASED AND PARKWAY CABLES • ARMORED CABLE • CRESFLEX NON-METALLIC SHEATHED CABLE • SERVICE ENTRANCE CABLE • MAGNET WIRE • BARE WIRE

CRESCENT



WARFLEX

A NEW Product!
Uses NO Rubber!

This new, factory-fabricated cable has been developed in response to the need for a wiring method that eliminates the use of rubber. WARFLEX is especially suited for Cantonments and War housing.

Send for Further Information and Prices

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Building Wires & Cables	Synthol Synthetic Insulated Wires
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Parkway Cable	Portable Cords and Cables
Signal & Control Cable	Flexible Steel Conduit
ABC Armored Cable	All other Standard Wires & Cables

CRESCENT INSULATED WIRE & CABLE CO.

CRESCENT
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Factory: TRENTON, N. J.—*Stocks in Principal Cities*

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Edgar E. Dawes	Paul Hogan, Jr.	Huie-Simmer Co.
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CRESCENT ENDURITE SUPER-AGING INSULATION . WEATHER-PROOF WIRE

NEW EQUIPMENT and MATERIALS

Insulation Tester

The Herman H. Sticht Company, 27 Park Place, New York City, has just developed a new model insulation tester, the model C-2 Megohmer, which, instead of using dry cell batteries, employs a new type, powerful, light-weight, spillproof, lead acid storage battery, which is also built into the instrument and is easily accessible. This storage battery is chargeable at any time from either a-c or d-c by means of a special self-contained charging cord which is contained in a small compartment on the side of the instrument and is, therefore, instantly available when needed. This new Model C-2 Megohmer has a megohm range of 0-200 megohms and three ohm scales, namely: 0-200, 0-20,000 and 0-200,000 ohms, giving the instrument exceptionally close readability from 1 ohm to 200 megohms.

This model operates on much the same principle of the B-5 Megohmer developed early in 1940. The B-5 model utilized a special vibrator-transformer by means of which a test potential of 500 volts d-c could be obtained simply by stepping up ordinary dry cell batteries of low voltage. This was introduced at a time when it became clear that imported hand-cranked generator type instruments would become difficult to obtain from Europe.

The response to this new type of insulation tester, made in the United States, was immediately a favorable one; and since then, a large number of these instruments have been sold to practically every industry in America and especially to plants doing important defense production work. The armed services of the United States likewise have been supplied with many of these instruments. This type of battery-operated megohmmeter has proved its worth through all this time; and, in view of the exceptional ease with which a battery operated insulation tester can be operated, it is now in a great many instances preferred to the old-fashioned, generator-driven instrument. Anyone who has cranked an old type generator for days will readily admit that such a method of testing and furnishing a test potential is very tiresome. The Model B-5 Megohmer furnishes a test potential of 500 volts simply by the throwing of a switch to the megohm range. All that is necessary is an occasional check to see that the proper potential is furnished. This is accomplished by pressing a push button and adjusting the pointer to the zero position.

The test potential of 500 volts d-c of the battery-operated B-5 Megohmer has been found to be exceptionally steady, much steadier than that of the variable pressure, generator-driven type instruments. This instrument has a range of 0-200 megohms and an ohm range of 0-2000 ohms, as well as two separate d-c voltmeter ranges, 0-300 and 0-600 volts, d-c.

The model B-5 Megohmer is described in Bulletin No. 430 issued by the Herman H. Sticht Company, Inc., of 27 Park Place, New York, and a copy is available without cost to anyone interested in the instrument.

Wiring Time Savers

Under the heading "10 Ways to Speed Up Wiring Jobs," the Ideal Commutator Dresser Co., Sycamore, Ill., has just issued a new folder describing a number of time-saving devices for the electrical contractor and industrial electrician.

Among the items described is a handy fish tape reel and puller; a joist borer; a handy wire and cable reel: "Snap-Tite" switchbox supports which hold any standard sectional switchbox in all types of composition walls; "Wire-Nuts" for making solderless and tapeless joints; a BX armor cutter designed to cut in one operation; the "Thermo-Grip" solderers used like pliers for controlled heat on solder jobs; "Screw-Tite" lugs, a pressure type lug that can be securely attached with screw driver, plier, or wrench; a cable ripper for cutting non-metallic sheathed duplex cable, lead covered cables, or other sheathing of other cords; and the "E-Z" wire strippers which clamp, cut insulation and strip the wire with one gentle squeeze of the handles.

A copy of the folder will be sent upon request to the Ideal Commutator Dresser Co., Sycamore, Ill.

Frank Adam Busduct

Bulletin No. 65, just announced by Frank Adam Electric Co., St. Louis, Mo., covers Busduct light and power distribution equipment for industrial plants. Today when there is such a severe scarcity of rubber and rubber products, insulated cable is becoming increasingly more difficult to procure. Therefore, the distribution of electric current for light and power by means of Busduct is becoming more and more of a common practice.

In modern war plants the Busduct distribution system is taken as a matter of course. But the fact is often overlooked that even in an existing plant where alterations are made in but a single department, it is very easily possible to use this more modern system of distribution because of its many advantages. Among these are—

(1) Its ready availability, as reasonably prompt shipments can still be had on most sizes.

(2) The ease of installation, which saves time and work stoppage, which is so costly these days.

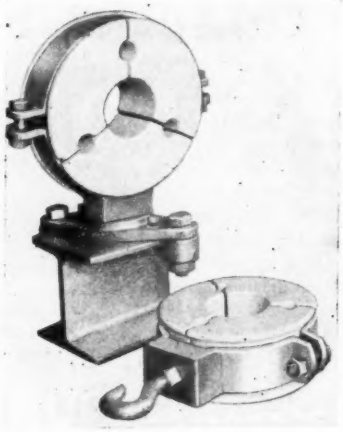
(3) Extreme flexibility, as it makes possible the attaching of plug-ins to feed motors anywhere along the line.

(4) High salvage value, which means that this Busduct can be moved from one plant or department to another and reinstalled at practically no loss of material whatever.

Open-Wiring Support

The present national emergency emphasizes the need for construction methods that save time, material and man-power. This explains the great increase in number of new plants that are adopting open wiring construction. A three-conductor support of type illustrated is of especial interest because no bronze is required in its manufacture. Saving of copper, tin and zinc is effected by the all-steel clamp construction. Clamp does not heat because all conductors are within the same metal ring.

Close triangular spacing provides a balanced electrical circuit with good voltage regulation and may permit use of smaller copper conductors than



Our Obligation

In the present war emergency, we recognize two very real and very definite obligations. They are:

1. *To avoid the continued use of materials which are now or which may later be placed on the "strategic" list. The successful prosecution of the war requires this sacrifice.*

2. *To make every possible contribution toward the continued existence of jobbers and dealers generally—and to the continued comforts and convenience of civilian life.*

MANY old-line housewares are rapidly vanishing from the market. Great dislocation is occurring in jobbing and retail organizations because of lack of sufficient merchandise to maintain sales volume.

Metals, rubber and other "essential" materials have always represented a very small percentage of the material requirements for our vacuum type glass coffee makers. Since the elimination of our electric stoves, this percentage is almost negligible. But after our present stocks are exhausted, there will be absolutely no strategic material in any Silex Coffee Maker.

Our raw material stocks will permit continued production of our present line of vacuum type coffee makers for the next sixty to ninety days or perhaps a longer period. A satisfactory substitute for the rubber seal has been developed. As many as three substitutes have been found to replace other scarce materials.

It is realized that vacuum type glass coffee makers alone will not serve to offset to any large degree the loss of sales on metal percolators, and coffee makers of other types; so, the Silex line is to be expanded to provide more merchandise for you to sell.

In the expanded line, there will be:

1. *Our vacuum type coffee maker*
2. *An automatic drip coffee maker*
3. *A straight drip coffee maker*
4. *An "extractor" type coffee maker*

It is a source of great pride to us to know that we still service millions of Silex Coffee Makers produced during the past thirty-five years. Our reputation for continued service over a long period of years will be maintained. Material will be available for replacement parts.

The Silex line will be aggressively promoted. And with the expansion in the line now planned, it is anticipated that our jobbers' and dealers' franchises will become increasingly valuable. In any event, assurance is hereby given that this Company will continue to serve the trade and the public in the best possible way, for the "duration".

Frank E. Wolcott

PRESIDENT

Genuine SILEX GLASS COFFEE MAKER

TRADE MARK REGISTERED U.S. PAT. OFF.

THE SILEX COMPANY, HARTFORD, CONN.

CREATORS OF THE GLASS COFFEE MAKER INDUSTRY

necessary with usual single-conductor horizontally spaced construction. The supports can be supplied with separable bases for beam, pipe or flat mounting, or with hook for suspension.

Manufactured by Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., and described in Bulletin 31-F.

Bulldog Product Catalog

A new condensed catalog, No. 426, has been announced by Bull Dog Electric Products Company, Detroit, Mich. The new catalog covers a wide range of equipment including safety switches, service equipment, Kbl-duct, lighting panels, SaftoFuse panels, vacu-break switchboards, circuit master and circuit breaker panels, and miscellaneous devices.

The chief change in this new catalog is the elimination of such items which it was felt desirable to drop from the catalog in the interest of simplification and the conservation of critical war materials.

A special feature of the catalog is the color section devoted to highlights of the Bull Dog bus duct and Trol-E-Duct systems as well as the engineering features of other Bull Dog products.

Fluorescent Extension Light

Designed at the request of a bomber parts manufacturer in Detroit who wanted a small, cool light for close work and inspecion in the restricted areas of bomber wings, Hygrade Sylvania is now manufacturing a Fluorescent Extension Cord Light for use in war plants.

Specifications called for a "streamlined" unit, small in diameter and less bulky than incandescent rough service extension cord fixtures.

The finished unit, rugged, light weight and compact, proved to be the answer not only to this customer's problem, but is also readily adaptable to all kinds of extension cord service.

Among the special features claimed for this unit are:

Cool light source; the fixture is so cool that it may be clipped to the worker's belt or hooked into the lapel of his coat, leaving both hand. free.

Fluorescent lamp replaced in a few seconds time. Remove two end cap screws, loosen two screws in other end, tilt back guard and slip out deactivated lamp.

Only eight watts total consumed, including lamp and auxiliary. Low brightness of the fluorescent light source is, perhaps, the greatest advantage of the P-7. Not only is this effective in reducing eye fatigue as a result of glare, but because of the reduction in glare, the effective illumination on the work is tremendously increased.

The grille protecting the fluorescent lamp is sturdily constructed of heavy gauge steel. The lamp is rated 110-125 volts, 60 cycle, a-c. Overall length (of unit): 9½"; overall width 1"; overall height: 1¾"; average weight: 2½ lbs.

Trumbull L.V.D. Busway

The Trumbull Electric Mfg. Company, of Plainville, Conn., in Circular 337, illustrates and describes new features of the L.V.D. (Low Voltage Drop) Enclosed Busbar Distribution System.

One of the interesting announcements is the addition of the new "Airated" L.V.D. System, in which the busbars are enclosed in steel casings provided with a series of openings which facilitate the circulation of air and so increases the current carrying capacity by some 35 to 50 per cent—which in turn reduces the cost of installation.

The new L.V.D. System conserves copper, steel and rubber. Circular 337 will be sent gladly, on request.

Handbook on Care of Motors

With motors operating 168 hours a week instead of 40 hours as formerly, most books on motor care are now seriously out-of-date. To correct this situation, Allis-Chalmers, Milwaukee, has just published a new handbook entitled "A Guide to Wartime Care of Electric Motors." Taking a fresh, new slant at the subject of motor care under war conditions, the book is of great value to war plant engineers and maintenance men, and is of particular value for training new men. The book contains no advertising, and is available upon request.

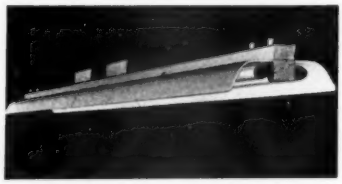
"IWI" Priority Letters

Recognizing the urgent need of electrical motor repair shops for up-to-the-minute information relating to priorities, Insulation and Wires, Incorporated, distributors of electric motor rebuilding materials, has made available to motor repair shops a "priorities letter" issued from time to time as important changes are made in the regulations and restrictions affecting materials used in the motor rewinding industry. These letters have been very favorably received by hundreds of motor repair shops. Motor shops not now receiving these letters may have their name added to the mailing list by writing to Insulation and Wires, Incorporated, 2127 Pine St., St. Louis, Mo.

Non-Metallic Fluorescent Unit

A new fluorescent industrial unit with non-metallic reflector will insure that war industries will be adequately lighted in spite of limitations on the use of steel. Curtis Lighting, Inc., has designed a new unit especially for war production industries and it will be ready for the market shortly.

These units employ CurtiStrip wiring channel (well-known to the electrical and industrial field) and are for two or three 40-watt lamps or two 100-watt lamps per reflector.



Eight or ten foot sections may be joined for continuous runs of any length, or reflectors may be omitted when desirable without interfering with the continuous wireway.

Ballasts and starters are mounted on top of the CurtiStrip, making them readily accessible at any point. The CurtiStrip cover snaps into the top of the channel.

The reflector is Fluracite which is a tough, white synthetic finish originated by Curtis after extensive research, and used on fluorescent reflectors for more than three and a half years. It does not discolor and provides a smooth surface of unusually high reflectivity for the hard durable non-metallic material of which the reflector is fabricated. Fluracite is easily cleaned with soap and water.

General Sealing Compound

Duxseal, a non-hardening adhesive sealing and caulking compound suitable for a wide range of uses, is offered by Johns-Manville. Used like putty, just as it comes from the package, the compound sticks readily to any clean surface without slumping, flowing, or hardening in service. It is insoluble in water, unaffected by ordinary gases and condensates, and will not hurt the hands.

Duxseal was originally developed by Johns-Manville for the electric power and telephone companies to seal openings in ducts carrying electrical conductors. Its usefulness, however, says the company, led to its general adoption by electricians, maintenance engineers, mechanics, plumbers, and home owners for general utility service.

The material is black in color and weighs 100-lb. per cu. ft. It is furnished in 1-lb. and 5-lb. pugs, in cartons of 60 and 12 pugs, respectively.

Three additional sealing compounds, similar in appearance and general characteristics, but differing in consistency and certain individual properties, have also been added. Pakseal is designed for service where greater stiffness and rigidity are required; Transolseal, for service requiring resistance to refined oils;

and Nodrseal, for use in food storage and refrigerators.

A four-page folder describing Duxseal and the other compounds has just been issued. Copies may be obtained from Johns-Manville, 22 East 40th Street, New York, by asking for Form EL-19A.

Ruberoid Insulating Tape

At a time such as this, when the sole aim of American industry must be production for victory, every hour of lost time, whether it be in a munitions plant or one serving civilian needs, is a handicap to the country's war effort. In the electrical industry, experience has shown that many work stoppages, and sometimes serious break-downs, could have been prevented easily and economically by proper insulation against moisture.

Particularly subject to trouble from outside moisture are conduit joints and other connections, motor leads, overhead cables, mine locomotive and mine machinery cables, telephone and electric light lines, certain exposed parts of industrial machinery, and virtually all forms of underground installations.

For adequate protection at these danger points the primary requirement is a form of wrapping having three outstanding qualities—imperviousness to moisture, strong adhesiveness and high resistance to abrasion. To meet this requirement a number of large companies in the electrical and mining fields have been for years consistent users of Ruberoid insulating tape — a product invented and first marketed by The Ruberoid Co. more than fifty years ago for heavy-duty work in coal mining and other underground operations. This tape, according to the manufacturers, exceeds A.S.T.M. specifications by 300 per cent in adhesiveness, 26 per cent in tensile strength and 290 per cent in dielectric strength. Further important advantages claimed are resistance to acids and alkalis and that the tape may be held in stock indefinitely without deterioration.

Air Circuit Breakers

Low-voltage air circuit breakers designed for use on alternating current circuits up to 600 volts and direct current circuits of 250 or 750 volts are described and illustrated in a new 12-page publication, Catalog 2150, just released by the Roller-Smith Company, Bethlehem, Pennsylvania.

These breakers, Type HD, are available in sizes ranging from 600 to 6000 amperes a-c, and 600 to 10,000 amperes d-c. They can be furnished in 1, 2, 3, and 4 pole models for either manual or electrical closing. Live front, dead front, and steel enclosed designs are available.

The catalog lists closing and tripping currents, shows typical methods of making connections to large breakers, gives dimensions of both manual and electrical designs, and indicates the number and size of terminals for various capacity breakers. Copies can be obtained without charge from the Roller-Smith Company, Bethlehem, Pennsylvania.

Reed Fan Catalog

A new sales manual for 1942 has been announced by the Reed Unit-Fans, Inc., of New Orleans, La. The manual is attractively illustrated and includes much helpful installation data as well as information on Reed unit fans.

"Quick Selector" Catalog

A 64-page 1942 revision of the "Quick Selector Catalog" is announced by the Westinghouse Electric and Manufacturing Company. Issued twice a year, this catalog has become extremely popular, as it simplifies the selection of many types of electrical equipment.

A number of additions and changes have been made in the new edition which make the catalog more useful than ever before.

The general subjects covered include: safety switches, no-fuze breakers, multi-breakers, panelboards, motor control and motors. New application data, on latest equipment in each of these groups, has been included.

Despite revisions, the general format of the catalog has been retained. Electrical ratings, physical dimensions, and circuit diagrams expedite the selection of correct equipment for each purpose.

A copy of the April 1942 "Quick Selector" Catalog 30-000 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Carboloy Tool Manual

Gathered together in a single manual for the first time — just published by the Carboloy Co., Inc., Detroit, Mich.—is material covering virtually every conceivable factor connected with the use of tungsten carbide tools, much of it previously unpublished.

Primary purpose of the manual (GT-133) is to assist defense industry. As the result of current pressure for increased defense production, more and more companies have been turning to carbide tools, while thousands of operators now being employed by industry are being put to work with carbide tools for the first time.

It is to meet these conditions — to speed the instruction of new operators, to facilitate the design, brazing, use and maintenance of carbide tools by new organizations, that the manual has been prepared.

Not only does it cover the design of carbide tools themselves — the selection of tool shapes, tip and shank sizes, relief angles, etc. — but it also covers such related items as design and setting of tool holders, machine recommendations, tool holder screws, correct methods of using coolants, etc.

For manufacturers desirous of producing their own tools, the manual provides complete instructions on torch brazing technique, materials, and equipment.

There are complete charts of recommended feeds, speeds, tool angles and depth of cut, for various materials — steel, ferrous castings, nonferrous and non-metallic.

For the tool room there are complete instructions for grinding tools, including recommendations as to machines, wheels, grinding technique and the design and grinding of chip breakers for tools used in steel-cutting.

Designed to simplify the carrying of tool stocks and enable faster securing of materials, the manual contains numerous illustrations of examples of how special tools can be produced from 'standard' tools by simple grinding operations.

A summary of various grades of carbides is included to assist Tool Engineers in selecting the proper grades for different jobs.

In addition to a valuable list of 'Do's and Dont's' for carbide tools, there are provided sketches of handling equipment found valuable in preventing accidental damage to such tools.

Dolph Insulating Varnish

Insulating varnishes and compounds are playing an important part in keeping motorized equipment in operation for the war program. Since it was founded in 1910, the John C. Dolph Company of Newark, N. J., has specialized in the manufacture of insulating varnishes and compounds and offers a wide range of products, some of the special uses of which are described in the following paragraphs.

When the repair man has a rush job, Dolph's No. 1 Coil Black Air Drying Varnish, which is an all-purpose black air drying insulating varnish, very often will solve his problem. In case a motor is in the shop for a minor repair, a few moments spent in retouching the windings with this varnish will more than compensate the time taken, as the life of the motor will be greatly extended. It has proven very satisfactory on all types of armatures and field coils where oilproofness is not essential. It is an air drying varnish which is easy to apply by brushing, spraying or dipping and will dry in 2 to 4 hours. Drying can be accelerated by baking.

When oilproofness is a factor, Dolph recommends an air drying product known as Electric Lacquer. This is a combination of natural gums blended to produce a smooth, glossy, black oilproof finish. It is particularly recommended for preventive maintenance work where it has proven its ability to prolong the useful life of generators, motors and all other types of equipment.

A periodic application of Electric Lacquer fills cracks and seals defects that develop in the original insulation. The finish provided is absolutely oilproof and waterproof and affords maximum resistance to acids. Like Dolph's No. 1 Coil Black, it is applied in the same manner and dries in thirty minutes to one hour.

For greater resistance to acids and caustic solutions, Synthite No. 10 Red Insulator is recommended. This material is composed of Bakelite gums and vegetable drying oils. It provides slightly greater flexibility than the conventional alcohol solvent red enamel. The finish is extremely glossy and absolutely oil and waterproof. An outstanding feature of this insulator is its ability to resist caustic solutions. Resistance can be increased greatly if units treated with this material are given a slight bake. Many prominent paper mills have found that Synthite No. 10 applied to the windings on their motors in the same manner provides more than ample protection.

Synthite No. 10 Red Insulator provides a build-up of 5 mils per coat and has a dielectric strength of over 850 volts per mil. This insulator can be applied in the same manner as the other Dolph products.

Further information may be obtained by writing the John C. Dolph Co., Newark, N. J.

Saflex Plug-in Duct

Square D Saflex Plug-in Duct has just been released by the Square D Company, Switch & Panel Division, Detroit, Michigan. It is an up-to-date method of supplying current or electrical energy to the many outlets demanded in modern industry.

Saflex Plug-in Duct provides accessibility of electrical energy in a most convenient and economical manner. Its original installation is not prohibitive in cost, and its flexibility will provide for easy additions in the case of unforseen requirements. The new duct is available in capacities of 250, 375, 500, 750 and 1000 amperes, in 2 and 3-wire single phase, 3-phase, and 4-wire service.

Square D Plug-in Duct utilizes round, tubular fuses for 250, 375 and 750 capacities, and solid, round bus bars for 500 and 1000 amperes. These round bus bars are contained in a steel housing which is produced in standard lengths. Six openings are provided on each side of a ten-foot length of Saflex Duct and will accommodate 12 plug-in units.

Industrial Fixtures

Day-Brite Lighting, Inc., of St. Louis, Mo., has recently announced a new line of industrial fixtures including single units and a sectional arrangement for continuous applications. This new line incorporates the use of open end porcelain enamel reflectors and has numerous advantages from a maintenance and installation standpoint.

The reflectors are readily removable from the wiring channel without the use of tools by merely unscrewing two large die-cast wing nuts. These wing nuts are prevented from falling out of the reflector, when it is removed, by half moon washers and are so designed that the pressure, when holding the reflectors in place, is exerted on the porcelain surface over an area 1½" in diameter. This distribution of pressure eliminates the possibility of the porcelain

BETTER LIGHT BUILDS AMERICA'S MIGHT

The best artificial light in the world is now available to the men and women working in America's battle of production—light made brighter, clearer, easier on the eyes by fluorescent lamps.

Many of the improvements in fluorescent lamps are due to Westinghouse skill in lamp design and manufacture. Many of them are the result of Westinghouse fluorescent lamp research. Today these technical and manufacturing improvements are resulting in more effective and efficient lighting.

For increased production, greater accuracy in workmanship, less fatigue for workers, let Westinghouse Mazda Fluorescent Lamps keep your fluorescent lighting at peak efficiency. Westinghouse Electric and Manufacturing Company, Lamp Division, Bloomfield, New Jersey.

Westinghouse

MAZDA FLUORESCENT LAMPS

chipping, without the use of additional asbestos or metal wasners. When these reflectors are removed for cleaning or for access to the interior of the wireway, the wiring in the channel is completely exposed.

When it is necessary to replace a socket due to breakage, the entire mounting plate, or saddle which supports the sockets, can easily be taken out of the wireway by removing two expansion type holding clips. This enables the maintenance man to replace the sockets on the mounting plate completely in the open, and eliminates blind work in wiring or installing the new socket.

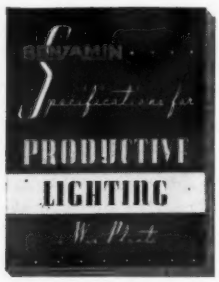
Installation of this equipment is simplified through the use of flexible channel mounting clamps used in connection with stem or pipe hangers. These mounting clamps can be positioned at any point in the entire length of the individual or continuous fixture, making it unnecessary to spot exact locations for mounting hangers or conduit. Lead wires can enter the wiring channel at any one or more of the many knockouts which are provided in the ends, sides and top.

As it is often necessary or advisable to rearrange a lighting installation, the continuous runs may be easily broken into individual units by removal of three screws in the coupling plates. The open ends of the wireway may then be covered by end caps so designed to use the same screw holes for attachment as the couplings.

The flexible channel mounting clamps mentioned before are designed specifically for this particular equipment. The wireway or wiring channel is formed to accommodate these clamps which can be used with ½" or ⅜" pipe or ⅜" rod.

Benjamin Catalog

A new lighting manual to meet the need for up-to-minute data on the use of lighting as a production tool in solving the problems of production, rejects, employee fatigue, accidents and morale, greater utilization of floor area, windowless plants, 24-hour operation, etc., is announced by the Benjamin Electric Mfg. Co., Des Plaines, Illinois.



Title of this new war-time lighting guide is "Benjamin Specifications for Productive Lighting in War Plants." It is designed to provide executives, plant men, architects . . . all those concerned with lighting in war plants, with the latest information on the best methods of using lighting economically and efficiently as part of the Production Drive.

Main section of the guide is devoted to the solutions for the twenty-one lighting problems most commonly encountered in plants converting to war production. These solutions are written in non-technical, easily understood language and are illustrated by means of diagrams and layouts, making it easy to put the solutions to immediate use. These solutions also serve as guides in the solution of similar problems.

In addition, these specifications show how to analyze the seeing task and to determine the amount of light and type of lighting which is needed for more efficient seeing on the part of employees. It shows how to select the proper lighting equipment and makes certain that it conforms to approved standards of design and construction. It summarizes how to get the most out of the present lighting system and how to conserve lamp life and electric power.

A complimentary copy of Benjamin Specifications for Productive Lighting may be had without cost or obligation by simply addressing the Benjamin Electric Mfg. Co., Des Plaines, Illinois.

Wiremold Lighting Units

The Wiremold Company, Hartford, Conn., announces publication of a new Catalog, No. FL-5, and Price List FL5-C1 covering Wiremold "V"-Type Cover Fluorescent Units and Line-O-Lamps adaptable to a wide range of fluorescent lighting applications in industrial plant buildings, factory offices, engineering departments, inspection departments, etc.

This equipment, being a further development of the Wiremold "3000" System for wiring and lighting, offers exceptional flexibility in installation, either as individual units or continuous-row Line-O-Lamps, providing also for future additions or extension by means of simple interconnecting fittings.

Wiremold "V" Type Cover Wired Units and Line-O-Lamps are listed by Underwriters' Laboratories, Inc. Fittings and hangers provide for installation either suspended from or attached to ceilings.

Multi-Range ClipOn Meter

A new multi-range ClipOn ammeter has been announced by Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y. The Ferranti ClipOn ammeter gives instant, accurate current readings without the necessity for opening the circuit or shutting down the equipment under test. In using it, it is only necessary to clip the meter around the conductor and the reading is instantly available. The ClipOn ammeter is designed for single-hand operation, being perfectly balanced to eliminate fatique. Its bakelite-enclosed, rectangular jaws quickly accommodate themselves to round or rectangular conductors up to 2¼" square.

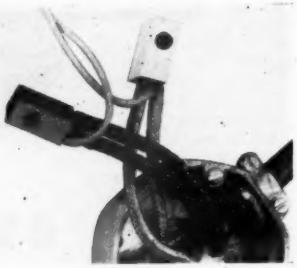
Among the many advantageous features of the new Ferranti multi-range ClipOn ammeter are the following: it reads up to 1,000 amperes; has one single set of scale divisions, and all scales are multiples of 10 or 25; it has five full scales of 0 to 10-25-100-250-1000 amperes; the clips are well insulated and very dur-

able; and it is completely self-contained.

The meter itself has jewel bearings, an open well-lighted dial, shatter resistant glass and a rugged bakelite case that is both dust and moisture proof.

Fixture Connector

A new fixture connector, made entirely of plastic, has been placed on the market for the H. B. Sherman Mfg. Co., of Battle Creek, Mich. This new fixture connector is of the set-screw type, and is said to be the only non-metallic fixture connector using a positive set screw for securely holding the wires in contact. It is made in two colors—red for the hot wire and white for the ground.



The plastic material itself is extremely tough and durable. The set screw may be tightened up with plenty of tension, to make a permanent job that won't jar or shake loose.

The body of the connector has been made slightly larger, and the Vee-shaped opening for the wires has been increased in size for faster, easier assembly.

This connector, of course, requires no taping, and can be installed with an ordinary screw driver.

Safety-Handle Fuse

Now more than ever safety is of vital importance for it means increased production. The Royal Safety Cartridge Fuse fills this need because the built on safety handle affords perfect insulation from current-carrying parts. No more accidents due to shorts and burns.

The patented handle is just where it is wanted when it is needed. No more delay caused by hunting for fuse pulling devices. Manufactured to N.E.C. Standards and listed by Underwriters' Laboratories. Available in 250 and 600 volts—1 to 200 ampere. For further information write to Royal Electric Co., Inc., Pawtucket, R. I.

Sailor—

WE EARNED THE NAVY "E"

Our pledge to the Navy

To the United States Navy and to the Nation, we of American Blower pledge the unstinted devotion of our experience, our ability, our effort. Whether destined for use on the battle lines, or to equip other essential industries for production of vital material — the products of our efforts, we pledge, will continue to measure up to the standard of excellence that is worthy of the commendation, "Well Done." We are proud of the privilege of working under the Navy "E" burgee — proud to wear the insignia conferred on us. By our progress in production, we shall continue to demonstrate our patriotism and determination to win. We are mindful of our responsibilities. We are working, and shall continue to work, for Victory!

MECH. DRAFT · AIR-CONDITIONING
AMERICAN BLOWER
FLUID DRIVES · DUST COLLECTORS

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CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN Radiator and "Standard" Sanitary Corporation

Personal Notes About Men You Know—

Election of four Westinghouse executives to the rank of vice-president has been announced by G. H. Bucher, president of the Westinghouse Electric and Manufacturing Company following action by the Board of Directors. They are **Andrew H. Phelps,** of Pittsburgh, Pa., manager of purchases and traffic; **L. E. Osborne,** of Philadelphia, Pa., manager of the steam division; **Frank** ident of the Westinghouse Electric Elevator Company, a subsidiary; and **Walter C. Evans,** of Baltimore, Md., general manager of radio, x-ray and broadcasting divisions.

Andrew Phelps

Mr. Phelps, general manager of purchases and traffic joined Westinghouse on January 1, 1937, coming from the McGraw-Hill Publishing Company where, for seven years, he served as sales manager and director of public relations. He attended the Georgia Southern Military College, at Bainbridge, Ga., and was a student of accounting and law at the Brooklyn Institute of Accountancy. For five years he served as business manager of the Brooklyn Y.M.C.A.; then became field manager of the Chamber of Commerce of the United States.

* * *

Paul Ramsay, formerly a partner in the electrical wholesale firm of Stokes-Ramsay Electric Company, in Chattanooga, recently purchased the interest of **Arthur Stokes** in the business, and will operate it under the name Ramsey Electric Supply Co.

Mr. Ramsay is well known throughout the South in the electrical industry. His first association with the electrical industry was with the Western Electric Co., in Atlanta, in 1911.

In 1919 he joined the Southern **C. Reed,** of Jersey City, N. J., pres-Electric Supply Co. In 1921 he joined the sales force of Albert Wahle of New York. In 1922 he became associated with the Arrow Electric Company, of Hartford, and in 1931 he opened a southeastern office in Atlanta for Arrow-Hart and Hegeman, where he served as manager until he established the Stokes-Ramsay Electric Co., in Chattanooga, in 1940.

Paul Ramsey

Single-Phase Motor Winding Design

(*Continued from page 42*)

In the tabulated windings Nos. 1 to 10, the starting winding turns per pole in per cent of the running winding turns per pole has been given in each case. On an average, the turns per pole for the starting winding can be considered as 62 per cent of the running winding turns per pole. Or if any winding that is being worked out checks up with any one of the typical windings, the starting winding data can be taken directly from the tabulated winding data with good results. From 50 to 65 per cent of the running winding turns can be safely used for the turns per pole for the starting winding.

The next step in laying out the starting winding is to determine the size of wire. This can also be done by using the running winding as a base. From the windings given in Nos. 1 to 10, it will be found that for four-pole motors the size of wire for the starting winding runs from four to eight sizes smaller than the running winding, or that on an average the starting winding wire size can be made six or seven sizes smaller than the running winding wire size. Then for a two-pole motor winding, the starting wire will be 11 sizes smaller than the wire used in the running winding. For two-pole windings, the turns per pole for the starting winding should not be less than 80 per

Revere Announces an Outstanding Line of NEW FLOODLIGHTS

ANSWERING THE CALL TO CONSERVE THE MORE CRITICAL MATERIALS FOR WAR NEEDS

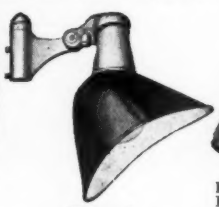
Easy to Wire — Easy to Install
Easy to Maintain

REVERE Floodlights are a boon to high efficiency in all applications. They are engineered to safeguard vital production, construction and civil services.

Fortify yourself by obtaining latest catalog supplements featuring the many new REVERE Units. Write to Dept. ES-742.

(Fresnel)
180° Fresnel Lens Wide Angle Floodlight—originated by REVERE for Protective Lighting. Available in 4 styles.

(150-1500 W.)
150 to 1500 Watt Enclosed Type Floodlights have many exclusive REVERE features.



(Eliptor)
REVERE Eliptor 300 to 1500 Watt. Outstanding in efficiency and ease of installation.

(Dust-tight)
DOME REFLECTOR
Dust-tight, Cool Operating, Dust Shedding—used in arsenals, loading plants, etc. Something new in principle. Underwriters approved — Class 2, Group G Locations.

REVERE ELECTRIC MFG. CO.
2939 NORTH PAULINA STREET · CHICAGO
Originators of the Hinged Floodlight Pole
INDOOR and OUTDOOR LIGHTING EQUIPMENT of EVERY DESCRIPTION

New Target for Industry:

More Dollars Per Man Per Month in the PAY-ROLL WAR SAVINGS PLAN

TO WIN THIS WAR, more and more billions are needed and needed fast—AT LEAST A BILLION DOLLARS A MONTH IN WAR BOND SALES ALONE!

This means a *minimum* of 10 percent of the gross pay roll invested in War Bonds in every plant, office, firm, and factory in the land.

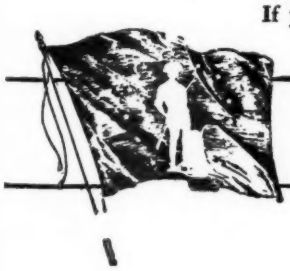
Best and quickest way to raise this money—and at the same time to "brake" inflation—is by stepping up the Pay-Roll War Savings Plan, having every company offer every worker the chance to buy MORE BONDS.

Truly, in this War of Survival, VICTORY BEGINS AT THE PAY WINDOW.

If your firm has already installed the Pay-Roll War Savings Plan, *now is the time*—

1. To secure wider employee participation.
2. *To encourage employees to increase the amount of their allotments for Bonds, to an average of at least 10 percent of earnings—because "token" payments will not win this war any more than "token" resistance will keep the enemy from our shores, our homes.*

If your firm has not already installed the Pay-Roll War Savings Plan, *now is the time to do so.* For full details, plus samples of result-getting literature and promotional helps, write, wire, or phone: War Savings Staff, Section E, Treasury Department, 709 Twelfth Street NW., Washington, D. C.



U. S. War Savings Bonds

This space is a contribution to America's all-out war program by

ELECTRICAL SOUTH

cent of the running winding turns per pole.

For the starting winding, the turns per skein or per slot are found in the same way as already explained for the running winding.

By following the methods explained in this article and studying the steps very closely, it will be found possible to take a three-phase or a two-phase core and calculate for it a single-phase winding that will give good results. On the other hand, a new winding can be worked out for a single-phase motor even when the original winding data are not known; or a starting winding can be designed for use with any main winding that may still be intact and in satisfactory condition.

Specialization In War-Work

(*Continued from page 35*)

would have no trouble in maintaining a profitable repair business—but since we haven't, we must go some other way."

The type of repair business for which Shelby Electric Company is fitted—large-scale conversion from a-c to d-c supply, complete system remodellings, power wiring, etc.,—has been "out" completely from early 1942 on, Mr. Hunt reports. "We were fortunate in having good stock of materials on hand when complete curtailment of supplies came around," he said. "We were thankful that we had a large stock of copper wire and fittings which are practically impossible to obtain today. This is only a temporary panacea, however, and in fact we have been operating on our reserve stock since April.

Without the material for replacing wiring, etc., there is no such thing as a repair market on our scale, and much as we would like to take up this field, we have been forced to give it up as one of those wistful situations which nobody can do anything about."

Ultimate solution at Shelby Electric Company, which now employs 80 men, including 30 shop electricians, and 50 engaged in installing electrical systems for direct or indirect war products contractors in the Memphis area, has been obtaining as much defense work as possible. When interviewed, Mr. Hunt credited a good 95% of his business to direct or indirect war work, bearing a good priority rating, and the kind of work with which his firm is experienced.

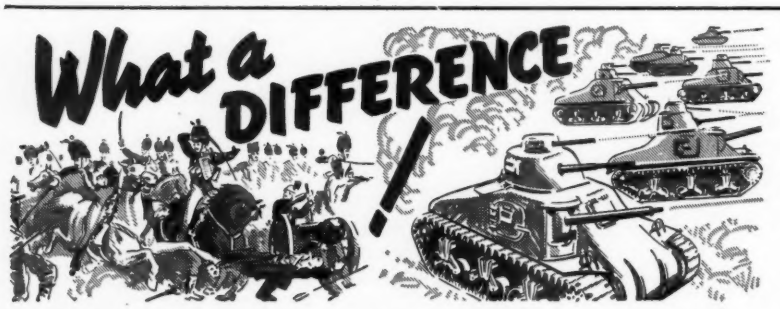
"A lot of contractors don't wish to tackle war work, for one or more reasons," Mr. Hunt said, "among which is the combination of troubles arising from labor, material shortages, lack of cooperation from suppliers, etc. However, we picked this work as our most logical occupation for the remainder of the war simply because it is closely aligned with the work we have done in the past, and because our shop facilities are geared to handle it. "There is not much selling required in this field; mostly a matter of getting to the potential customer, figuring the bid correctly, and getting it in with all risks eliminated in advance.

"We took the chance that our reputation was such that future customers would depend on us entirely to make the job what they desired, and are pleased to find that it has worked out. We haven't added any new equipment, having put in new lathes, testers, and other equipment early last year—and of course, these facilities have been most helpful."

Shelby Electric Company's present war contracts include a huge army depot near Memphis, a 1600-bed hospital now under production, a local powder plant, and numerous sub-contractor factories which have mushroomed since the early stages of the war in Europe. Mr. Hunt feels that the smaller contractor—the man with insufficient financing or resources to take large contracts—will be worse hit by war conditions.

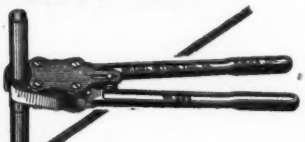
Shelby Electric Company has put in bids consistently on large-scale work which attracted major electrical companies as much as a thousand miles away, and with good judgement, has been successful in obtaining many of them. The highly competitive nature of war construction contracts, particularly those let by the government, is a "good thing for the industry" Mr. Hunt believes, inasmuch as contractors accustomed to overlooking small details in bid figures, and to trusting to luck, will now be forced to learn the risky business of estimating "from the ground up."

Interesting to note is one aspect of the repair field which Shelby Electric Company has been main-



And there's just as much difference between the *streamlined* BRIEGEL METHOD of making conduit connections and old-fashioned methods.

The BRIEGEL METHOD saves you up to 50% on time and a substantial saving on materials allowing you a larger margin of profit on each job. Make quick, easy, strong and neat connections this MODERN way.



No extra turns or twists, no nuts to tighten when you use B-M connectors and couplings. Just TWO SQUEEZES with the patented B-M indenter (which costs you only $1.25) and you have a smooth efficient job. Approved by Underwriters Laboratories.

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taining steadily—addition and augmentations of existing installations now required to make a larger output. In such additions, Mr. Hunt has been unusually successful in using a large percentage of second-hand wire, conduits, switches, etc. In installing additional motor lines and lighting, or example, Shelby Electric has made a policy of scouring the yards of local junk dealers, and demolishing firms, many of whom buy the materials of entire factories at razing time. Here, it is possible to find wire which can be easily reconditioned and reused, and many electrical fittings. For example, when the Fisher Body plant in Memphis was converted over to war manufacturing a few months ago, junk dealers bought the entire stock of electrical materials—all of which Shelby Electric Company contracted for immediately afterwards.

"It is surprising, the amount of good wire which can be found" Mr. Hunt said. "Of course, we do not re-use damaged or split wire of any kind. However, going through a junk yard, we have been able to obtain 200 and 300 feet lengths of wire which can be reconditioned, spliced, and handled as easily as new wire. We are buying all of this we can obtain, coiling it up, and putting it in stock to be used specifically on remodelling or addition work."

Such a system, of course takes a large part of the pressure off new wire stocks, and Mr. Hunt has taken the reasonable stand that every foot of re-used wire provides him with one foot more of new wire for more urgent new-installation work.

"We are attempting to concentrate our re-used materials in additions to local Memphis plants," he said, "although there are many in the area of a 150 mile circle around the city." Most such jobs involve no priority rating, and were it not for timely substitutions, Mr. Hunt would have to turn them down.

Largest change from a physical standpoint at Shelby Electric since the beginning of the war has been the addition of extra plant space which, though idle at present, protects Mr. Hunt against any number of unforeseen exigencies. At the left of the main Memphis plant, a 500-sq.-ft. brick building has been added, which will give a good deal more storage room, space for rebuilding motors if and when copper becomes obtainable, and to maintain vital electrical equipment for

. . . WITH THE HELP OF YOUR
GraybaR LIGHTING SPECIALIST

Lighting of the highest SEEING QUALITY can be simpler than you think. The basic requirement is that it be correctly chosen to fit the visual task with adequate provision against glare and shadows.

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To take advantage of this or other specialized GRAYBAR services on signaling, power apparatus, and the like, just call your local GRAYBAR office.

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SILVRAY SPEED-LIGHTS are the SIMPLEST source of lighting of high seeing quality, thanks to the light control principle of the silvered-bowl lamps.

The reflector-hood serves as a self-contained ceiling, making possible efficient redirected lighting regardless of ceiling construction.

Widely applicable to present outlet spacing, using 150-200-300-500 or 1000 watt silvered-bowl lamps.

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SAVE HOURS OF WORK WITH BETTER TOOLS

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Get the facts about the complete line of Greenlee Benders and attachments for tubing, conduit, pipe, and bus-bar ranging from ¼ to 4½ inches, in the Greenlee Bender Booklet, S-116.

BENDERS

This Greenlee Folder S-114 describes the handy Greenlee Knockout Tools for enlarging knockouts and holes in metal without long tedious drilling, reaming, or filing.

KNOCKOUT TOOLS

The Greenlee Cable Puller Folder S-115 shows how this handy tool, which clamps right on to the conduit through which the cable is pulled, can make the tough job of cable pulling easy for the electrician.

CABLE PULLERS

Here's the Greenlee Folder S-113 which describes a few of the popular fast and smooth-boring bits from the complete line of Greenlee Boring Tools.

BORING TOOLS

For the contractor interested in learning how to lower underground pipe installation costs, this Greenlee Folder S-117 describes the powerful Greenlee Hydraulic Pipe Pushers.

PIPE PUSHERS

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Please send: ☐ S-116 Bender Booklet ☐ S-114 Knockout Tool Folder ☐ S-115 Cable Puller Folder ☐ S-113 Boring Tool Folder ☐ S-117 Pusher Folder.

Name_____

Address_____

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My Jobber Is_____

GREENLEE TOOL CO.

1767 Columbia Ave., Rockford, Illinois

existing industries.

"We will use the new plant for manufacturing cedar cabinets, substations, machine parts, etc," Mr. Hunt summed up. "We haven't installed any machinery as yet, waiting to see which way the wind will turn—but whether we become manufacturers, store house, or a repair organization, we will have the necessary facilities."

Open Wiring for War Production Plants

(Continued from page 31)

of 600 ft., the load voltage being 220, load power factor 80%, and permissible drop assumed 3%.

Current per wire is (35,000 ÷ 1.73) x 220 x .80 or 115 amperes. Try 500,000 cir mil cable.

From table, the voltage drop per phase per ampere per 1000 ft. at 80% load power factor is 0.0434%.

Total voltage drop for our problem is, therefore, 0.0434 x .06 x 115 or 2.99%. This being within the limit allowed, the wire size selected is correct.

The actual voltage drop per phase is 0.0299 x 220 or 6.58 volts, and the voltage at source should be at least 226.58, or say 227 volts.

Dealer Essential No. 1: "Reduce Your Overhead"

(Continued from page 29)

extreme rear, and allowing maximum display space inside. "I'd rather have a well-filled small store than an empty-appearing big one," he pointed out. This move reduced rent from $500 a month to $140. At the same time, Mr. Radford let go four servicemen and two service and delivery trucks, selling the latter outright. All refrigeration service, delivery and repairs will be contracted for in the future, to solve the tire problem and high salary overhead simultaneously.

Next, Mr. Radford trimmed down his office personnel. Concentrating on cash business in a single store. He didn't need extra bookkeepers, credit men, etc.; consequently, he cut personnel cost from $750 per month to $225. In total, these methods lopped $4,400 per month from Oak Appliance Company's former overhead, and put Mr. Radford in a position to stand tough business conditions with minimum worry.

How about the business in the future? "We are going to put the same effort which once went into selling new appliances into procuring used merchandise," Mr. Radford said, "and sell every bit of it for cash. The solution to present difficulties is an extremely liquid business with low overhead, and one in which contingent liabilities are not a factor. We are selling 50 per cent of our reconditioned equipment for cash and the other 50 per cent on such large down payments and short terms that it is the equivalent of cash. We will arrange a bank loan for customers who want credit, and discount notes, but we will not tie up funds which we need for purchasing used appliances. I have discovered that $2,000 in sales of this nature are as profitable as $5,000 in long-term credit sales of the past, and that we are doing the cleanest business since I started in the appliance field."

The biggest problem of the new system, of course, will be procuring enough used appliances to sell. There are many more customers than appliances, particularly now that defense production is bringing 40,000 new families to New Orleans. Oak Appliance Company is using daily classified newspaper ads with such copy as "Highest cash prices for used refrigerators, washing machines, ranges, etc." and circularizing neighborhood districts with handbills making the same offer.

Salesmen Buy Used Equipment

Mr. Radford went to other dealers having accumulated trade-ins for part of his stock, and to warehouses holding furniture and appliances seized for charges for more. He feels that he can obtain still more from families moving away from New Orleans, who will sell their appliances rather than ship them. Salesmen are using the telephone to cold-canvass poorer districts for used appliances, and will hop in their cars and go out immediately to appraise any appliances offered. Mr. Radford does most of the appraisal work himself; allowing a cash price for each which will permit a 50 per cent markup for the store after absorbing drayage and reconditioning costs. Thus, maximum allowances to date average $20 for refrigerators, $5 to $15 for washing machines, and commensurate prices for other equipment. Surprisingly, salesmen spend most of

their time outside the store in buying, rather than selling—since 95 per cent of the business is with "walk-in" customers. "We won't wear out tires when the customer is willing to come to the store," Mr. Radford grinned.

All used equipment purchased is delivered direct from the owner's home to a refrigeration service firm handling all Oak Appliance work on contract. Using mass-production methods, it requires only an average of two days to tune up refrigerators, check and repair motors on washing machines, etc., before they move to the sales floor. Seldom does any appliance stay more than two or three days—so that the process of buying, reconditioning and selling usually occupies less than a week. High speed turnover of this type is keeping the store busy, and funds free for more buying.

A somewhat unusual additional saving on overhead which Mr. Radford has developed concerns his two huge front display windows—which are now paying the overhead of the store through rental to other companies for demonstrating their products. Each window measures 10 x 15 feet, plenty of room to stage "action displays." In ordinary conditions Mr. Radford pointed out, pride would keep him from utilizing the windows in this way — but now every phase of the business must pay a profit, so he has rented one window for $150 a month for a demonstrator of a special steel-sharpening device. That $150 is $10 more than the total rent of the store, incidentally.

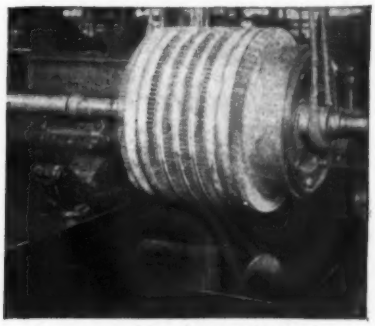
"The demonstrator using our window taught me a lot," Mr. Radford added. "In the future, if we are not renting the space, we are going to use demonstrators ourselves, pretty girls operating used washing machines, ranges, etc., to attract attention. I watched this man bring in $50 or more a day selling a low-priced gadget, and feel that we can do as well with appliances."

The nearest thing to a substitute line put in by Oak Appliance Company is a complete stock of gas floor furnaces in 30,000, 50,000 and 70,000 Btu sizes. These, selling for from $120 to $150, are being stocked for defense housing projects going up in New Orleans. One salesman is calling on contractors offering special prices on large orders, and others are sell-

G-E Varnished Tubing used on power leads in radio chassis for extra protection.

G-E Twine being applied to front end of commutator to provide extra protection.

G-E Varnished Tubing applied to coil leads affords extra protection.



Large armature about to be dipped into G-E Insulating Varnish for extra protection.

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WITH *Extra Protection* .. USE

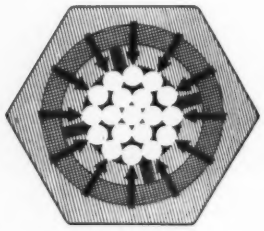
G-E INSULATING MATERIALS

Victory demands preparedness. Insist that your equipment is prepared with the *extra protection* of G-E Insulating Materials.

The complete line of high-quality General Electric Insulating Materials is fully described in the G-E Insulating Materials Catalog. For a copy, please see your nearest G-E Merchandise Distributor, or write to Section M-723—16, General Electric Co., Appliance & Merchandise Department, Bridgeport, Conn.

GENERAL ELECTRIC

"Gorilla Grips" make perfect contact!



The cross-section shown above illustrates how the conductors are compacted and gripped around the complete outside surface by the "Gorilla Grip" Connector. Loose contacts or distorted conductors set up high resistances and are often the real cause of motor failure. National Electric "Gorilla Grip" Connectors are designed to compact the cable and permanently hold, insuring a perfect electrical connection.

Write for a catalog.

Three Way Connector

National Electric
PRODUCTS CORPORATION
300 FULTON BUILDING, PITTSBURGH, PA.

ing floor furnaces in the store just as any other appliance, at a flat cost which does not include installation. Obtaining the floor furnaces direct from the factory, Mr. Radford has made them highly profitable, and an excellent supporting sideline for his 100 per cent cash used-appliance business.

Commutating Equipment Maintenance Chart

(Continued from page 25)

Poor commutator surface; see specific surface fault in evidence.
Depreciation; see 24.
High contact resistance; see 55.

Heating at Brushes:

Severe load condition; see 38, 41 and 42.
Faulty machine adjustment; see 7, 10, 11, 12 and 26.
Severe sparking; see "Sparking."
Raw streaks on commutator surface; see "Streaking or Threading of Surface."
Embedded copper; see "Copper in Brush Face."
Wrong brush grade; see 56, 57, 58, 60 and 61.

When the Bombs Begin to Fall!

(Continued from page 22)

exterior lights on the plant property should be extinguished. Whenever possible it is well to control the exterior lighting circuits from some centralized point. In any event, it should be an assigned duty to turn off all lights.

If emergency lights are needed out of doors they should be installed according to lighting recommendations soon to be issued by the Office of Civilian Defense.

The use of outdoor emergency lights should be restricted and they should be used sparingly at gates, entrances, strategic areas and the like.

It should ke kept in mind that even a minimum of emergency light shining on black or dark surfaces is more noticeable from above than if the surfaces are of a light color.

Extra effort should be made to eliminate any possibility of light reflection out of doors as from pools of water forming after a rain and the like.

If any signal lights within the plant belong to the plant or are under the control of the plant, such as railroad, bridge, dock, barge and traffic signals, and they cannot be extinguished, a shield should be provided over the top of the light and such shield should extend out beyond the light so that the light cannot be seen at an angle higher than that for which it is intended.

If such signal lights are under the jurisdiction of railroads or municipalities, or controlled by navigation rules, the proper authority should be approached to obtain their cooperation.

During a blackout all locomotives, trucks, automobiles and other conveyances which must continue operation should be equipped with devices recommended by the Office of Civilian Defense or be required to turn off all lights while on company property.

There are various methods that can be employed to indicate the aisles and gangways in buildings or to denote pavements and roadways. Obstacles can be treated to show up in the dark, and even equipment can be treated in such a manner that it is possible to operate it within certain limitations.

Among the methods that may be used without danger of visibility at even the lowest altitude at which planes might travel are the following: (1) luminous paint

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You can't go *"all-out"* when you're *"all-in"*...the air-conditioned, noise-proofed rooms and inner-spring mattresses at Hotel Mayfair renew your energy.

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which gives off a phosphorous glow, especially useful for markings and warnings; (2) clear transparent glass spheres stuck into a special pigmented binder for marking boundaries of aisles, lanes, etc.; and (3) use of special fluorescent dyes and paints activated by ultra-violet or "black" light.

Control of Power and Lights During Blackouts

It would, of course, be an ideal situation if all electric power and light circuits could be controlled from one centralized point such as from the office of the plant defense coordinator. This method is too expensive as a rule to install in an existing property.

If a plant does not work during the night hours or if there is a portion of the plant that can be segregated and is not working during the night hours or has no regular occupancy, the main power and light circuits should be switched off providing such power and light circuits do not feed installations of air compressor, fire or service pumps or some other strategic facilities necessary for the defense or operation of the plant or for the emergency lighting service. By so doing, the chances of electrical fires, shocks and electrocutions are greatly minimized in case of trouble.

Plants or sections of plants that work during the night hours should carefully go over all electric power and lighting circuits to make sure that they are in good order and also properly mark the control switches for all areas so that in case of trouble only the area involved will be cut off if necessary.

This is especially important in many types of industries where processes must be kept operating so that the equipment or material being processed will not be destroyed or badly damaged by power failure. Power must also be kept on certain ventilating systems exhausting dust, gas, fumes or vapors that might be hazardous to life or cause damage to the property.

The main telephone switchboard serving the plant, the plant defense coordinator's office and any dispensary or first-aid unit in the plant should be provided with emergency battery lighting sets to be used in case of failure of the regular electrical systems. Extra bulbs and sockets should be provided in case of bulb failure.

Preheating Process Improves Insulation

(*Continued from page 23*)

The synthetic type varnishes do not depend only upon oxidation and evaporation for drying but some go through a process called polymerization or curing when subjected to the increased baking temperatures necessary to obtain the qualities called for by modern electrical coil design. When properly baked, units treated with this type of varnish will not soften under heat nor will the varnish throw-out under the centrifugal force developed in high speed motors.

Considerable savings in baking time are effected through their use and a maximum degree of mechanical strength can be obtained. Higher dielectric strength, too,

"Automatic"
TIME
CONTROL DEVICES
Models for
And desired time cycle
Any function specified
Any performance wanted

PROCESS TIMERS

INTERVAL TIMERS, or PROCESS TIMERS, are furnished in two types. One is reset by hand (manually); other resets itself automatically. Both types can be provided for practically any cycle of time, fully adjustable from zero to maximum period. SYNCHRONOUS, SELF-STARTING MOTORS.

SIGNAL TIMERS

Used extensively for starting and stopping industrial work; school class periods; for municipal time signals, etc. Up to six signal periods, permanently set at factory with Sunday & Holiday Cutout and Manual Control, at a price of only $35.

TIME SWITCHES

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All three types can be furnished with capacities ranging from 20 TO 200 AMPERES PER POLE, from $12.00 up. Ten ampere Time Switches from $3.95 up.

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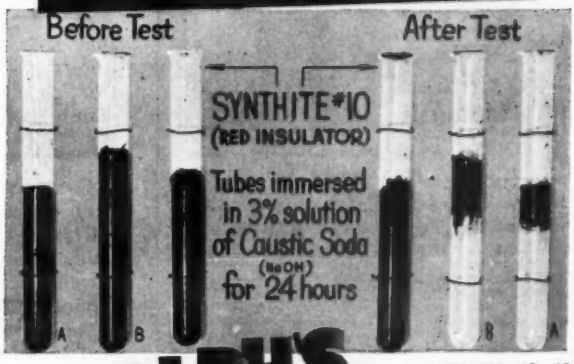
This test proved that electrical insulation can be longer lasting!



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SYNTHITE NO. 10
RED INSULATING ENAMEL

Tubes prepared with SYNTHITE No. 10 and two competitive red oilproof enamels were immersed in a 3% solution of caustic soda (NaOH) for 24 hours. The results, illustrated above, showed that SYNTHITE No. 10 had no sign of breakdown or loss of its high gloss. Application of SYNTHITE No. 10 is simple; it can be sprayed or brushed. Oilproof and waterproof, SYNTHITE No. 10 has high dielectric strength and high arc resistance. Fast air drying; for both interior and exterior use. Specify SYNTHITE No. 10 today for lasting insulation efficiency.

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FASTER
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AVAILABLE NOW — "Wire-Nuts" do not use critical materials, Lead, Tin and Rubber, as required for solder-and-tape joints, so you get prompt delivery. The "Wire-Nut" threads onto the wire, like a nut on a bolt. Thousands of Electrical Contractors have standardized on "Wire-Nuts" because they make neater joints — better electrically, stronger mechanically. Fully Approved; listed by Underwriters' Laboratories, Inc. Sizes for every job. MILLIONS IN USE!
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goes hand in hand with extreme toughness and greater resistance to oil, water, acid and alkali.

With the advent of these newer types of varnishes, new methods of varnish treatment of coils have come into existence. In order to obtain the necessary dielectric and mechanical strength so vital to the satisfactory performance of the new type of equipment, baking of varnish treated units has been found to be essential.

Maintaining Electric Motor Controllers

(*Continued from page 19*)

It is not always possible, however, to mount the relay in the proper position, and when it is in the out-of-true position it is less dependable. Shortening the pendulum makes it possible to tip the relay further from the vertical, but the shorter pendulum results in a shorter time delay.

To overcome this limitation a new design that has a balanced pendulum has been made available. The variation in time is obtained by changing the length of the stroke. In principle the two devices are the same, but mechanically they are quite different.

If the old-type escapements fail to time properly, their mounting position should be checked. However, if the application is such that it is difficult to mount and keep the relay in the proper position, use of the balanced type should be considered.

When Corrosive Gases Are Around

Corrosive fumes in many plants, such as those manufacturing rayon, coke, sulphuric acid, nitric acid, chlorine, and so on, rapidly attack the metal parts of control devices and render them inoperative.

To overcome this trouble all the operating parts are frequently immersed in oil in a container capable of withstanding the corrosive atmosphere. The container is made either of cast iron or of heavy boilerplate steel, which is given a protective coating of a paint that is capable of withstanding the fumes of gases encountered.

When it is impracticable to oil-immerse a given type of control, the equipment is enclosed in a heavy case with a tight, gasketed cover. The enclosing case is protected with a suitable corrosion-resisting paint.

Control equipment can be quite simple or very complex, and the job of the maintenance man is easier if he has available instruction books and wiring diagrams covering every piece of control and every circuit for which he has responsibility. Extra coils and contact tips should be kept on hand as well as a complete list of spare parts. Maintenance is simplified considerably if the maintenance man makes a practice of becoming thoroughly familiar with the circuits and operation of each new controller as it is installed in the plant.

How to Keep 'em Turning

(*Continued from page 15*)

the insulation between the commutator bars slightly. After turning down the commutator, the brushes should be sanded and run in as described previously. This is not necessary after light sandpapering or stoning.

Never put oil on the commutator.

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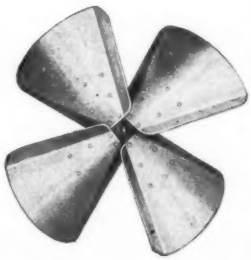

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Junction and Pull Boxes

Write for Listings

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Proper selection of brushes gives the commutator all the lubrication required to prevent excessive wear and to build up a good smooth operating glazed surface on the copper. The addition of oil results in the development of a high resistance film which may cause undue heating and rough brush action. The oil will also have a detrimental effect on the internal parts of the commutator.

Planning Industrial Lighting Maintenance

(Continued from page 9)

normal to the monorails mounted on the truss chords.

This traveling bridge method is used in the Lockheed and Vega aircraft plants and very economical maintenance results. The Vega plant installed a bridge on existing monorail crane-ways and cut the servicing time to one-eighth the time formerly required. The bridges are towed by the monorail cranes.

Ways to Minimize Maintenance

If the maintenance method is established at the time of designing the building, a minimum maintenance cost is bound to result. In addition to the above general methods of access to lighting, there are other factors to consider such as luminaire designs, reflecting and transmitting materials and methods of mounting luminaires.

Luminaires should be easy to relamp and must have permanent reflecting surfaces or transmitting media that is easy to keep clean. Maintenance time can be minimized by installing units which permit removal of the reflector and lamp from the hood as a unit (see Figure 7). This type is particularly desirable where reflectors are to be maintained from a ladder, portable platform or crane, because reflector and lamp can be removed and replaced by a clean unit with only one trip up the ladder. Several extra clean reflectors are kept on hand to rotate with the dirty units.

Another method of installing detachable equipment is to support the complete luminaire from a special type of hook and plug assembly. The electrical plug is so arranged in relation to the mechanical hook that the luminaire cannot be removed from the hook until the plug is completely removed from the receptacle. These special hangers are available with two-wire plugs for incandescent or mercury units and with four-wire plugs for combination luminaires.

Fluorescents Need Special Care

Fluorescent equipment usually requires more servicing than mercury or incandescent because the units are more complex and contain more parts. Therefore, it is good practice to suspend this equipment by a detachable hook and plug method, so that complete luminaire can be removed from service and taken to a suitable location for a thorough inspection, test and necessary repairs. Fluorescent units can usually be checked quicker and more accurately on a test bench than hanging.

Where particularly dirty conditions exist, dust-tight luminaires will require the least amount of maintenance (see Figure 8). Mercury, incandescent and fluorescent equipment is now available with dust-tight covers and should be installed in foundries, forge shops, railroad shops, some parts of machine shops, welding shops, or other locations where dirt will collect rapidly on reflectors.

Careful selection of the luminaires plus a properly designed maintenance system will actually result in continued satisfaction with the lighting. Maintenance foresight is a low cost means of preventing high servicing charges during plant operation.

Test Insulation the Modern Way
with a MODEL B-5
MEGOHMER

No more tiresome cranking of a hand-driven generator.

This entirely self-contained instrument operates with a steady test potential of 500 volts DC, available at the touch of a switch. Direct readings in insulation resistance.

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101. SERVICE EQUIPMENT AND LOAD CENTERS—Service Equipment, Load Centers and Panelboards assembled with Type AC circuit breakers are listed in this new publication. In addition to considerable general information, it includes specifications and price data. Frank Adam Electric Company, St. Louis, Mo.

105. COOLAIR HOME-COOLING FANS—FORM 141 — Complete descriptions of 1941 Coolair single and twin attic fans, window fan and new automatic ceiling shutter. Also contains valuable installation suggestions. Designated as Form 141. American Coolair Corp., Jacksonville, Fla.

113. INTERPRETING THE NEW CODE IN TERMS OF NEW BUILDING WIRES—A new booklet describing the rulings on thin, heat-resisting and synthetic insulations are carefully simplified. The ratings of the newly recognized types of wires and the new ratings for Type R are graphically shown in tables for both the new and rewiring classes of work. General Cable Corporation, 420 Lexington Avenue, New York, N. Y.

114. IDEAL PRODUCTS CATALOG — A special 25th anniversary catalog has just been issued describing the complete line of Ideal Products. Electrical Contractors, Motor Rewinders, and Industrial Maintenance Electricians will be particularly interested in this comprehensive publication. Ideal Commutator Dresser Company, 1270 Park Avenue, Sycamore, Ill.

115. FLUORESCENT LIGHTING ACCESSORIES—Fall Bulletin No. 3, describing and illustrating complete Lloyd line of Fluorescent Lamp Holders, Starters, Starter Sockets and Holder and Socket combinations. Lloyd Products Company, Providence, R. I.

117. MECHANICAL CONNECTORS—First Aid for electrical systems through the use of mechanical connectors is the subject of an interesting twenty-page booklet now available. In addition to specific construction and sales of the new "Gorilla Grip," this booklet describes a wide range of mechanical connectors for every size and purpose. National Electric Products Corp., Pittsburgh, Pa.

120. SQUARE D COMPANY announces the Spring issue of the Square D Digest, dated April, 1941. This condensed catalog contains listings and the latest prices of many Square D products, including Safety Switches, Service Equipment, Multi-breakers and other Circuit Breakers, Panelboards, Motor Control and Pressure Switches. Square D Company, Detroit, Michigan.

129. BULLETIN 403 on BullDog enclosed bus bar system of electrical distribution for commercial and industrial use. Forty-four pages of construction details, applications, dimensional data and technical charts. BullDog Electric Products Company, 7610 Joe. Campau Avenue, Detroit, Michigan.

132. INDUSTRIAL WIRING HANDBOOK: This 48-page handbook, called "Adequate Wiring for Industry," describes modern factory wiring methods and materials. Wiring practices adaptable to all factories are outlined. Publ. No. 51-4011. General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.

142. ELECTRICAL CONDUIT — Complete technical information on corrosion-resisting asbestos-cement ducts for underground and overhead service, with and without concrete envelop, is included in "Transite Conduit and Korduct for the Electrical Industry," DS. Series 410. Johns-Manville, 22 East 40th Street, New York, N. Y.

148. LITTLE GIANT RELAY—A new small Relay for use on A.C. or D.C. is described in a Ward Leonard Bulletin No. 105. The Relay is available in single pole, single or double throw contacts. On standard frequencies, coils can be obtained for 6 to 230 volts. Complete information on contact rating is given in the bulletin. Ward Leonard Electric Company, Mount Vernon, N. Y.

149. ELECTRIC RANGE UNITS—Chromalox Bulletin CF-107 lists proper assembly and adaptor ring to fit any range, regardless of age or make. Inventory investment and servicing reduced to minimum. Units same as used on many makes of new ranges. Edwin L. Wiegand Co., 7600 Thomas Boulevard, Pittsburgh, Pa.

155. ELECTRICAL CONNECTORS — 325-page catalog describing and illustrating Burndy clamp connectors for overhead distribution and transmission, substations, grounding, underground distribution and industrial wiring. Contains 84 pages of useful technical information. Company asks that requests for the catalog, Catalog No. 40, be written on company letterhead. Burndy Engineering Co., Inc., 107 Eastern Boulevard, New York City.

156. INTERVAL AND PROCESS TIMERS—Furnished for any cycle of time, fully adjustable, for any purpose, any requirement, or any specified action. Each one built to meet individual specifications. Give information regarding what unit is to be used on, what it is to be used for, and what it is expected to do. Both Manual and Automatic Reset types available; individual or repeatingly continuous operation. Automatic Electric Mfg. Company, Mankato, Minnesota.

157. PROGRAM OR SIGNAL TIMERS — Used extensively for starting and stopping working hours, marking the beginning and ending of school class periods, sounding municipal time signals, and so on. Write for descriptive circular. Automatic Electric Mfg. Company, Mankato, Minnesota.

158. ELECTRIC MOTOR REBUILDING MATERIALS CATALOG — 28 pages — gives complete descriptions, specifications and prices on all materials and replacement parts necessary for the electric motor rebuilding shop. Insulation & Wires, Inc., 2127 Pine Street, St. Louis, Mo.

159. NEW COMPLETE FLUORESCENT CATALOG NO. 114—Lists in detail fixtures for every type of lighting application. New units abound in this book which is sure to be welcomed as the complete story on fluorescent by architects, contractors and jobbers alike. Day-Brite Lighting, Inc., St. Louis, Mo.

160. ELECTRICAL CONNECTORS — Complete up-to-date catalog of Handy Electrical Connectors and devices for repair, maintenance and new construction. Ask for publication Z-103. H. B. Sherman Mfg. Company, Battle Creek, Michigan.

161. RECTIFIED FLUORESCENT LAMPS AND LUMINAIRES—A recent booklet describing RF lighting especially designed for industrial lighting needs. Illumination layout data and illumination tables illustrate this booklet. Lamp Department, General Elec. Co., Nela Park, Cleveland, Ohio.

163. TIME CONTROL DEVICES—Engineering data on automatic reset timers and Time Delay Relays suitable to control hundreds of industrial operations. Numerous specific applications described. Paragon Electric Co., 409 South Dearborn Street, Chicago, Ill.

164. INSULATING VARNISHES AND COMPOUNDS—40-page catalog assists in selection of the right insulating varnish or compound to meet any specific requirement. Contains helpful temperature conversion and tank capacity tables. Lists and describes all standard grades of DOLPH air drying and baking insulating varnishes and compounds. John C. Dolph Company, 166 Emmett Street, Newark, New Jersey.

165. TECHNICAL DATA ON J-M TRANSITE ASBESTOS-CEMENT ELECTRICAL DUCTS—including installation and special fitting data on J-M Transite Electrical Conduit and Korduct—a bound set of technical data sheets on the two asbestos-cement duct materials. Primarily prepard for designing engineer and installation supervisor, the 42-page book is chuck-full of practical information for anyone concerned with underground or overhead duct installations. Tables giving dimensions of ducts and fittings and numerous installation photographs are included. Copies of the book, Form DS Series 410, may be obtained upon request to Johns-Manville, 22 East 40th Street, New York City.

166. ATTIC FAN MANUAL—New 6-page bulletin entitled, "Hy-Duty Ventilators for Every Use"—Form No. 347-A—specifications, data and information on the installation of Fresh Air Maker Ventilators. New 4-page folder entitled, "Your Patrons Like A Fresh-Crisp Atmosphere"—Form No. 402—descriptive of the Fresh Air Maker for commercial purposes. Schwitzer-Cummins Company, Heating Division, Indianapolis, Ind.

167. NATIONAL ELECTRIC ENGINEERING DATA BOOK—A 350-page engineering data book and catalog of National Electric Products is now available. In addition to the section containing tables and wiring data, this publication includes complete catalog specifications and prices on conduit, industrial busways, surface raceways, "Plug-In" strips, armored cable, flexible tubing, "Gorilla Grips," brackets and wireholders, fuses, and wire and cable. A special feature of the publication is a listing of the Federal specifications with which the National Electric Products comply. National Electric Products Corporation, Pittsburgh, Pa.

168. GREENLEE TOOL CATALOG NO. 33-E — a 48-page catalog of GREENLEE TOOLS for bending conduit and tubing, pushing pipe underground, pulling in cable, punching holes in steel cabinets and panels, boring holes in wood and doing various other operations. Greenlee Tool Co., 1766 Columbia Ave., Rockford, Ill.

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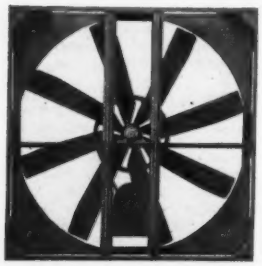

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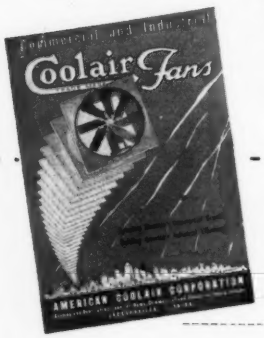

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